FEBRUARY 1960

Agricultural Engineering

The Journal of the American Society of Agricultural Engineers

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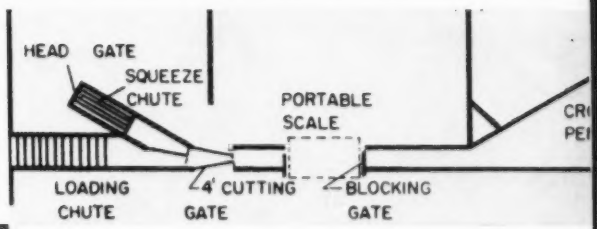

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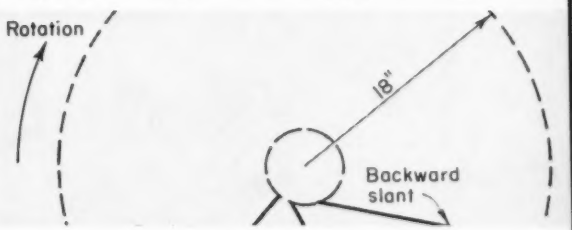

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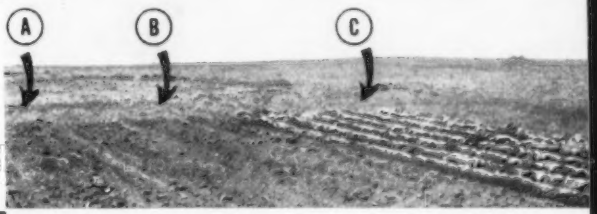

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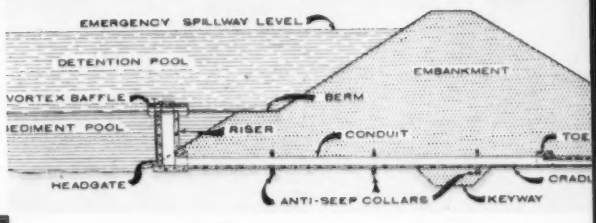

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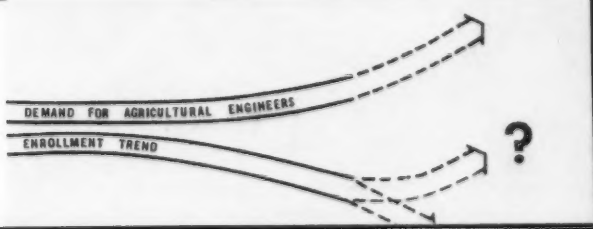

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N/D's new integrally sealed, heavy-duty conveyor ball bearing shuts out moist and dry abrasive contaminants . . . reduces assembly time and eliminates costly relubrication maintenance.

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Now you can cut conveyor operating and assembly costs substantially with the *new* heavy-duty N/D conveyor roll ball bearing.

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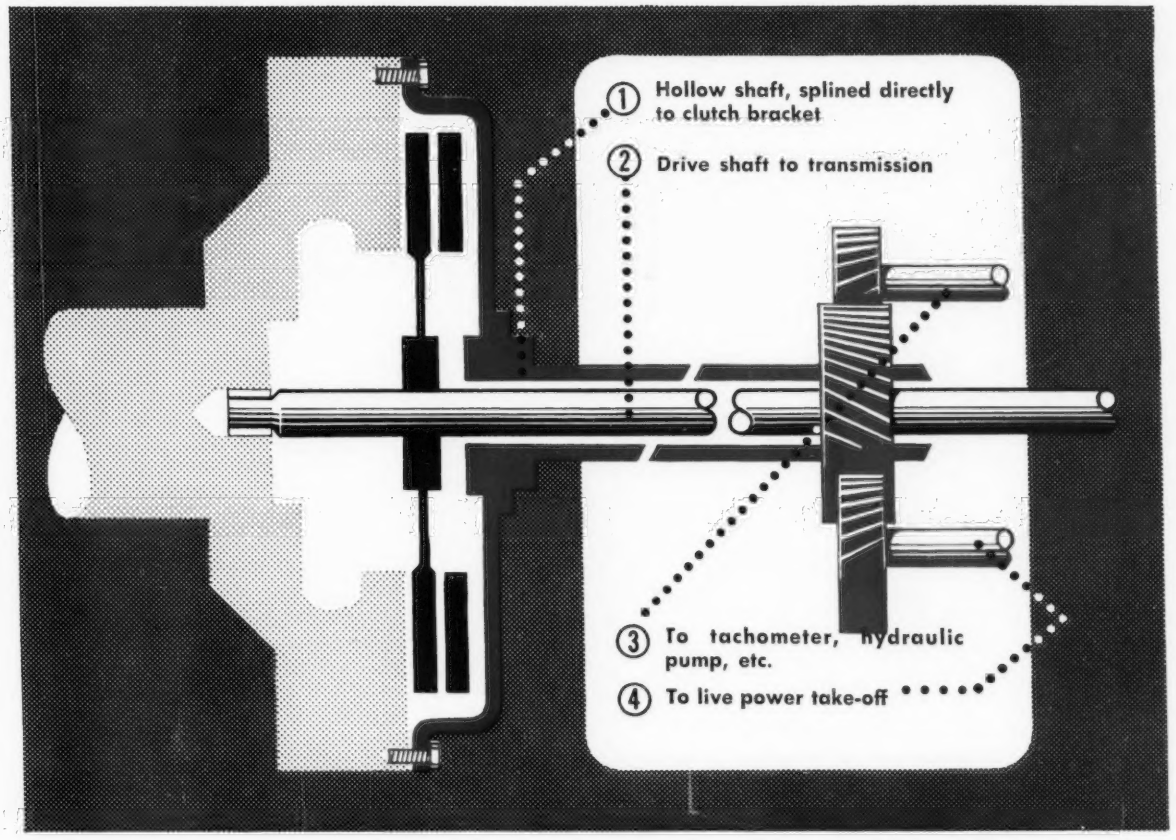
SPICER SPLIT-TORQUE CLUTCH provides a second and continuous source of take-off power


1 Hollow shaft, splined directly to clutch bracket
2 Drive shaft to transmission
3 To tachometer, hydraulic pump, etc.
4 To live power take-off

The Spicer Split-Torque Clutch delivers power to two shafts . . .

- One is the drive shaft — the same as you'll find in a conventional transmission. As usual, power is controlled by engaging and disengaging the clutch.
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Investigate the advantages of the Spicer Split-Torque Clutch before you finalize your design. The Dana engineer will be glad to show you how its second source of power can be used to best advantage.

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Agricultural Engineering

Established 1920

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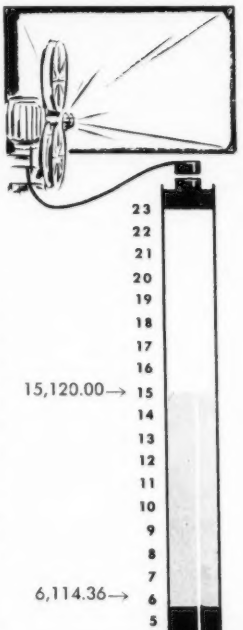
Farmstead Engineering Conference

THE American Society of Agricultural Engineers, Farm Structures Division, in cooperation with the Agricultural Engineering Research Division, ARS, USDA, and Departments of Agricultural Engineering and University Extension, University of Illinois, will sponsor a Farmstead Engineering Conference on confinement housing of livestock, in Gregory Hall, University of Illinois, Urbana, September 13-15, 1960.

The objectives of the conference are: (a) To present the most advanced information from the standpoint of management, breeding, feeding, sanitation, marketing, and other future considerations which may affect farmstead engineering; (b) to present basic and functional requirements of animals in a way that is useful to designers; (c) to present design procedures and solutions for combinations of components for economical operations; (d) to point up areas in which basic research is needed; (e) to focus attention on cost vs. returns of engineered-housing systems; (f) to focus attention on power requirements of engineered farmsteads; and (g) to publish this material in a special issue of the Journal for easy reference.

One-half day sessions will be devoted to each of the following: Poultry; swine; dairy; and beef. One evening session will be devoted to cost vs. returns from engineering farmsteads, and meeting capital requirements for engineered farmsteads. The second evening will consist of a dinner meeting in which "future farmstead power requirements," and "from where will the power come," will be discussed. On the afternoon of the third day, a tour of research installations is being planned.

The September issue of AGRICULTURAL ENGINEERING will be devoted entirely to farmstead engineering and by reason of the scope of the material it will contain, including all papers presented at the conference, promises to be a comprehensive handbook on the subject, suitable for the engineer, manufacturer, dealer, and farmer alike.



ASAE Motion Picture Report

DURING the month of January cash received for the ASAE Motion Picture Fund was at its lowest since the Motion Picture Progressometer was introduced in this column in October. Commitments have been increased by $115.00, or equal to cash received during the month from individuals, bringing the total to $15,120.00. Contributions from individuals and a payment from the Chicago Section increased the cash received to $6,114.36.

The number of paid up Sections now totals 22. The South Carolina Section reports that it met its own quota by member contributions and its portion of the Southeast Section quota was contributed by the So. Carolina Farm Electrification Council.

Watch this column each month to observe the progress of the motion picture project.

Torrington Needle Bearings are available for shafts up to 7¼" in diameter. Full complement of rollers provides highest radial capacity for a given cross section. They offer low unit cost, compactness and light weight and long service life. They take a press fit in a simple straight-bore housing, run directly on hardened shafts, permitting use of larger and stiffer shafts.

Why not put a Torrington Needle Bearing on that large shaft?

You have everything to gain by applying a large diameter Torrington Needle Bearing in your heavy duty applications.

There's the unusual economy in price and installation cost over other anti-friction bearings of comparable size. Simplicity of design of related components saves even more. Unequaled capacity for a given cross section, good lubrication and efficient anti-friction operation mean long service life.

These advantages have been proved in performance in tractor bolsters, transmissions and final drives. In haybaler crank shafts. In power shovels. In heavy duty hydraulic pumps and starting motors. In road wheel arms on tanks. Why not talk over *your* application with your Torrington representative? **The Torrington Company, Torrington, Conn.—and South Bend 21, Ind.**

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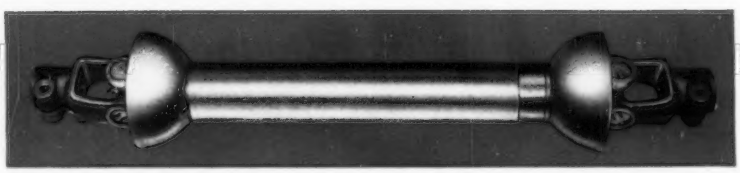
used on another new farm implement

Greater hay cutting capacity, plus long and dependable performance, makes this New Idea unit an outstanding improvement in mowers. It is the only mower that cuts a ten-foot swath of hay in one pass, with others cutting a seven-foot swath.

The Blood Brothers product used on New Idea's mower is a shielded drive from tractor P.T.O. to gear box. It is typical of the many drive assemblies Blood Brothers furnish for both specialized and conventional farm implements. Manufacturers know that only these highest



quality components—products of specialized Rockwell-Standard engineering—can best meet their particular needs.

When you consult Rockwell-Standard engineers, you benefit from a wide range of application experience—involving everything from manual steering assemblies . . . to power take-off drives . . . to heavy-duty propeller shafts. Let Rockwell-Standard save you time and money—to help you achieve higher standards of equipment performance.

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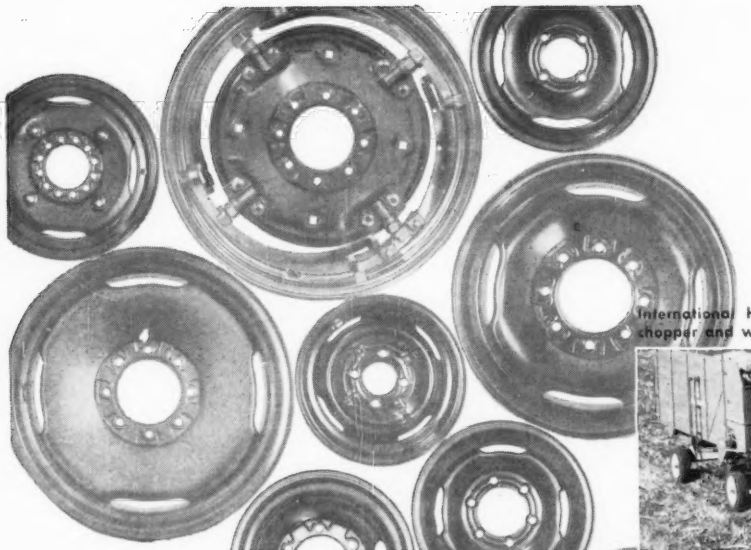

International Harvester corn picker-shopper and wagon.

Oliver tractor and semi-mounted plow.

Massey-Ferguson baler.

Allis-Chalmers tractor and All-Crop drill.

MOTOR WHEEL

"Application Engineered" wheels meet exacting farm machinery requirements

02

Modern mechanized farm machinery demand wheels designed to exacting requirements. That's why Motor Wheel has developed a complete line of "Application Engineered" wheels . . . wheels engineered to the special needs of farm tractors and implements.

You can depend on "Application Engineered" wheels. Behind them is Motor Wheel's matchless engineering and manufacturing experience . . . experience gained by pioneering such developments as disc wheels, S.A.E. reversible wheels, and the use of power adjusted wheels.

Before specifying wheels for your machinery, consult a Motor Wheel field sales engineer. He'll help you select an "Application Engineered" wheel, or arrange to have a wheel designed which will solve your unique wheel problem. Phone or write today.

Serving the Agricultural Industry Since 1903

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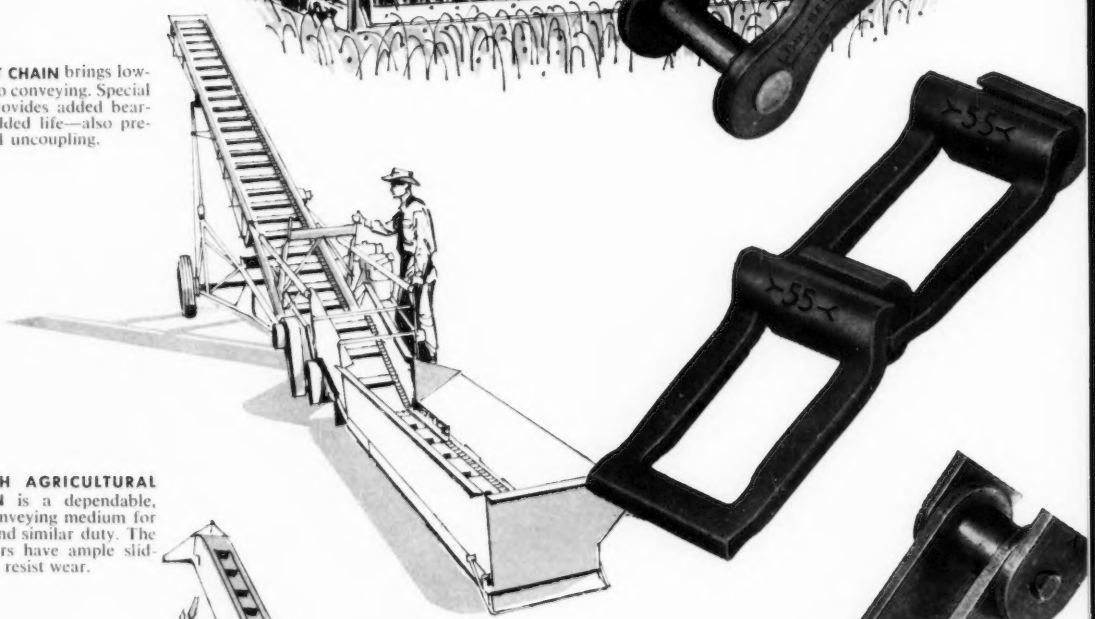
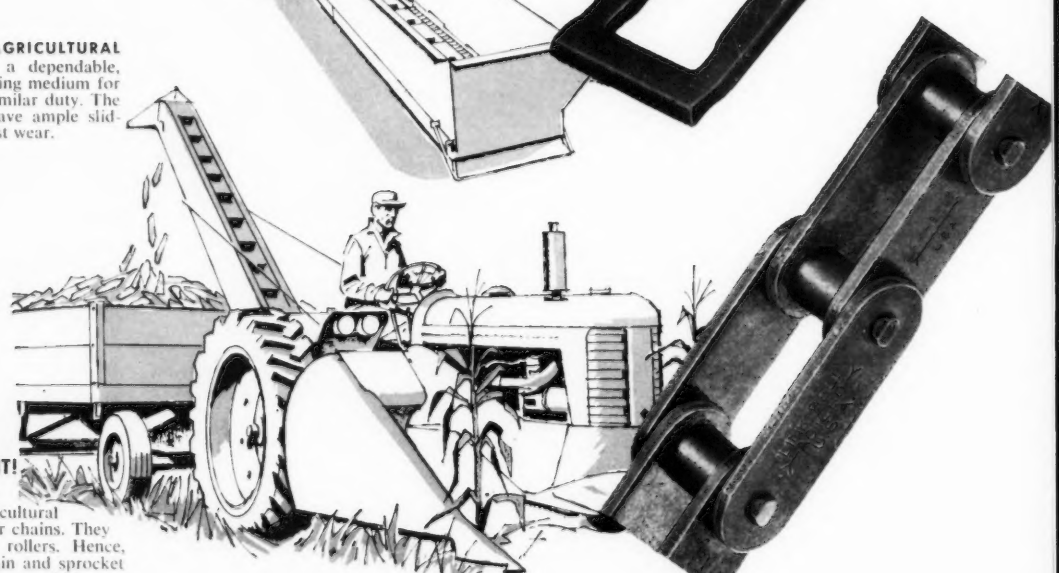
✻ **STANDARD-PITCH PRECISION STEEL ROLLER CHAIN** is a popular choice for transmitting power on such equipment as self-propelled combines. It features high hp capacity and light weight.



STEEL LINK-BELT CHAIN brings low-cost efficiency to conveying. Special hook design provides added bearing area for added life—also prevents accidental uncoupling.

✻ **DOUBLE-PITCH AGRICULTURAL ROLLER CHAIN** is a dependable, long-lasting conveying medium for corn picking and similar duty. The straight sidebars have ample sliding surfaces to resist wear.



✻ **IMPORTANT!** Link-Belt Roller Chains for the agricultural field are *true* roller chains. They have *free-turning* rollers. Hence, longer life for chain and sprocket because there's no scrubbing or sliding over sprocket teeth.

the leaders

Over 300 quality-conscious farm machine manufacturers rely on Link-Belt for chain . . . and bonus services besides

THE finest farm machine can be stopped dead in its tracks by chain failures. That's why so many foremost manufacturers want the best in chain . . . and therefore, choose Link-Belt. The leaders realize that the many refinements built into Link-Belt chain make a vast difference in field performance. And this important consideration, they know, helps assure customer satisfaction for their quality machines.

Link-Belt chains easily withstand the day-in, day-out punishment encountered in the field. They shrug off impact and shock loading . . . provide smooth, positive, all-weather service. There's consistent quality and unvarying pitch uniformity in every link.

Link-Belt offers industry's most complete line of drive chains, conveyor chains, attachments and sprockets. Also, "bonus" services that aid the designer, improve the design: application counsel, field analysis, laboratory service and others. These services multiply the *value* of Link-Belt chains . . . but because they are offered as standard features, *they don't multiply the price!*

On any drive or conveying application, take advantage of Link-Belt's unmatched facilities, experience and services. For details, contact your nearest Link-Belt office. Ask for 640-page Catalog 1050, covering the complete line of Link-Belt conveyor and power transmission products.

400 CLASS PINTLE CHAIN is a durable, reliable performer often applied on row crop harvesters. Closed link barrel prevents foreign materials from working into the pin joint.

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Report to Readers . . .

IMPROVED SPEED REGULATION OF ENGINE GOVERNORS RECOMMENDED

Up to 66 percent greater engine efficiency was obtained by reducing engine speeds in tests conducted by two Ohio State University agricultural engineers with five gasoline and three diesel-engine tractors. The improvement in thermal efficiency was obtained by reducing engine speeds on light loads, which was attributed primarily to reduction in frictional-horsepower loss. . . . . There was greater improvement in efficiency at optimum hand-throttle settings in the case of the small tractors than for the large ones, and this effect was more pronounced at lighter loads. The engineers recommend improvement in the speed regulation of present governors. The governor, they say, should provide adequate regulation from rated engine speed down to approximately one-half that speed. In the tests reported, fuel savings resulting from operation at optimum speeds ranged from 11.1 to 33.0 percent over the calculated work life of the tractors tested.

PLASTIC AND RUBBER GUARDS FOR POWER TAKE-OFF SHAFTS

From Britain comes news of development of a shielding means for tractor power take-off shafts. This guard is of two types - plastic and corrugated rubber. The latter type is for use on shafts with slip clutches, or of large cross section or other special features. . . . . The plastic-type guard is adapted to the majority of applications being interchangeable over a wide range. An important advantage of the plastic tubing is that it is extremely tough, will not rust, and cannot buckle. It provides a cone-shaped, slip sheath that is flexible and telescopic enough to allow necessary movement on the power take-off shaft. If an operator's clothing or body comes in contact with this spinning guard, it stops at once since it is free to rotate on the shaft.

TESTING PLASTIC PIPE FOR SUBSURFACE FARM DRAINAGE

ARS (USDA) and Cornell agricultural engineers are engaged in a joint research study of the need of farmers for lower cost subsurface drainage. They have designed and are in process of testing mechanically installed plastic drains. Some of these drains have been under field evaluation for over two years and are reported as still performing satisfactorily. . . . . Since these low-cost drains need to have sufficient strength to withstand the heavy surface loads imposed by the heavier farm equipment now in use, the effect of these heavier loads is being investigated by the engineers. The experiments thus far indicate that drains installed deeper than 18 inches can withstand the normal stresses applied in the operation of farm machinery.

ENGINEERS DEVELOP METHOD FOR BULK CURING TOBACCO

A research team of North Carolina and USDA agricultural engineers appears to have brought the mechanization of tobacco farming closer to success. They have discovered that bulk curing of bright-leaf tobacco - curing whole or shredded leaves in a tight pack - is possible. Not only will this eliminate about three-fourths of the hand labor now needed in curing tobacco, but bulk curing will require one-sixth as much barn space as conventional curing. In addition, with improved regulation of temperature and drying rates, it will be possible to produce a high-quality tobacco.

BRITISH FARMER MAKES HAY WITH COMBINE HARVESTER

A Hampshire, England, farmer has speeded up haymaking by using his combine harvester for that purpose. He uses an 8½-foot machine fitted with a grass knife and cuts the grass (tall meadow fescue and young oats) in the normal way. The grass is crimped by the cylinder and concaves as it passes through the machine and falls to the rear in a swath. It is then stirred with a tedder two or three times, and baled when cured. . . . . Before using the combine for haymaking, the grain elevator is removed and the sieves closed. A $\frac{5}{8}$-inch clearance is provided behind the concaves, and the machine is run at maximum drum speed. The amount of crimping is controlled by the normal drum settings. This crimping action helps to speed the curing rate, resulting in haymaking time being cut by at least one-half. The machine is said to work better where the grass crop is heavy than where it is light.

(Continued on page 74)

RARE SAND PROVES BEARING DESIGN

in new 100,000-mile test!

The automotive shaft bearing above has just completed the equivalent of 100,000 miles of dusty backroads travel. For hours, it's been alternately spun and stopped in this special mud . . . mud composed principally of a rare type of Arizona sand, *so fine it penetrates almost anywhere water can go.*

The particles of this unique sand are so small that, mixed with water, even filtering won't remove them all. They're highly abrasive, too—so much so that bearing failure quickly occurs whenever particles penetrate into a bearing raceway. Though several score of spin-and-rest cycles in this bath are equal to 100,000 miles of heavy-duty use on the road, the BCA bearings tested on this machine consistently stand up under many more cycles, before failure from sand penetration.

This test is typical of the many being conducted in BCA's new testing laboratories for BCA customers. Here, and in the expanded research laboratories, testing of bearings to exceed customer specifications is a daily occurrence. Often test equipment is specially built to exactly duplicate equipment in the customer's plant.

BCA provides a wide range of ball bearing sizes and types for nearly every kind of industry. This, plus extensive new research, testing, and precision production facilities make BCA a dependable source of long-life bearings. For information, write Bearings Company of America, Division of Federal-Mogul-Bower Bearings, Inc., Lancaster, Pennsylvania.

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ACCELERATED TESTING OF FARM MACHINERY CONTRIBUTES TO LONGER PRODUCTIVE LIFE

Farm equipment industry engineers are looking more and more to accelerated testing as a necessity in developing new farm implements and machines. To "accelerate" a test signifies more than speeding up on-the-farm testing long practiced by manufacturers. It means a thorough engineering approach to all phases of an application problem. Usually accelerated durability tests are found to result in products of higher quality than is the case where durability testing is done on farms along with functional testing. . . . . A particular advantage of shorter test programs is that they make it possible to respond sooner to requests of farm users for changes in machine types and specifications. This of course means that machines are thereby likely to have a longer productive service life before becoming obsolete, and this of course facilitates the amortization of tooling costs. . . . . In setting up a functional testing program, it is necessary also to include the use of popular current models of implements and machines, primarily to make certain that the new models will, in every way, exceed the performance of current models.

LISTER-PLANTER ATTACHMENT PLACES FERTILIZER WHERE PLANTS NEED IT

Two USDA agricultural engineers have devised an attachment for commercial two-row lister-planters for side-band placement of starter fertilizer. The device has special application in the US Great Plains area where listing of corn on the contour is a desirable practice for conserving soil and water. The device places the starter fertilizer 2 inches to the side and 2 inches lower than the seed. Thus the roots of the young corn plants reach the phosphorus in the fertilizer sooner and use it more efficiently. This placement also prevents the poor stands that result when the nitrogen in the fertilizer comes in contact with the seed. . . . . For the banding operation, a short runner-type subsoiler similar to the seed-furrow opener was mounted below and behind the lister point. The fertilizer opener was placed 9 inches ahead of the seed opener and 2 inches to the side, and bolted to a bracket welded to the lister frame. The regular planting adjustment was unchanged and the fertilizer depth adjustment was made to correspond.

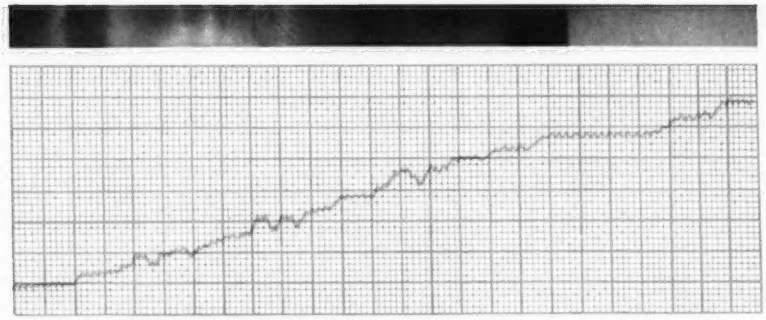
NEW RIGID LUMBER FRAME FOR FARM BUILDING CONSTRUCTION

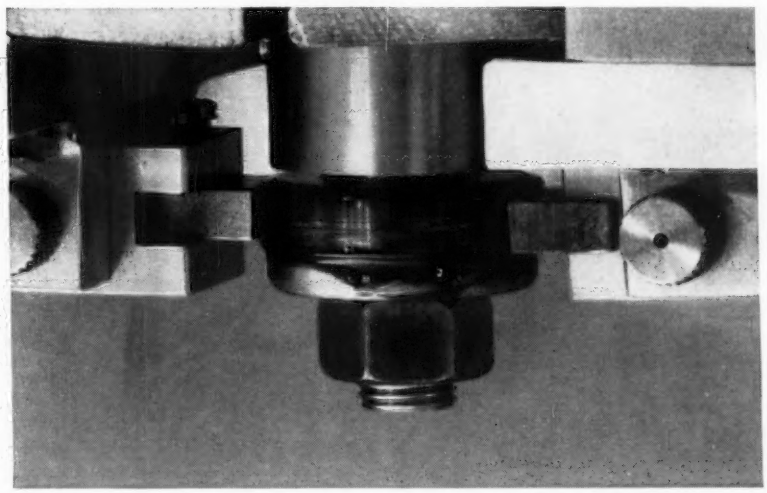
Illinois AES agricultural engineers have developed a new building frame they believe may revolutionize construction of farm buildings. It is made of lumber and consists of two studs and two rafters made rigid by plywood gussets glued and nailed on each side of each angle. In designing the framing of this building, accepted procedures of structural analysis were used to determine stresses in members. . . . . More usable space is made available by the rigid frame than do conventional construction methods, since it does away with the need of such interior obstructions as ties and posts. Construction is also cheaper since the rigid frames can be made at the building site, or by local lumber yards or builders, and they can be erected quickly and easily.

MECHANICAL FEEDING OF HOGS SAVES BOTH LABOR AND FEED

Agricultural engineers at the University of Wisconsin recommend a confined hog-raising system under which limited feeding will produce leaner, meatier carcasses. With a confinement system where the number of pigs being fed is large, even a slight saving in the feed required for each 100 pounds of gain may amount to a considerable saving over the feeding period. . . . . The Wisconsin engineers recommend mechanical, limited feeding of large numbers of hogs to reduce labor requirements. The system they have designed accurately weighs out easily adjustable, predetermined amounts of feed, conveys the feed to the pens and distributes it in self-feeders. All this is accomplished merely by turning a knob on an electric control panel. Adjustments to increase or decrease amounts of feed are made on selector switches before a feeding cycle is begun. . . . . The engineers believe the principles used in developing this hog-feeding system may be applicable for accurate feeding of other types of livestock.

WE TAKE THE PULSE OF BEARINGS ON TAPE TO MAKE THEM EVEN BETTER!





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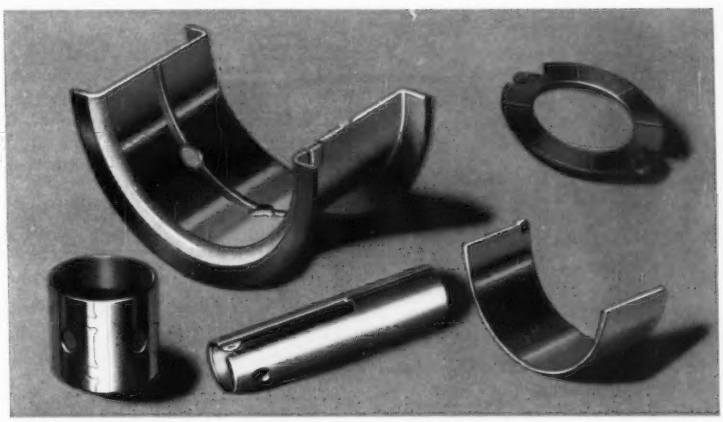

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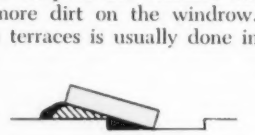
Terrace building is Ernest Bailey's business – a good business, and one he does well. Mr. Bailey's Cat No. 14 Motor Grader is ideally suited for building terraces in his community – and he keeps his machine busy doing it. His equipment is pictured at work here on the M. R. Mills farm east of Erick, Oklahoma. S.C.S. specifications on this farm call for a terrace base to be 20′ wide, 2′ high. Topography is rolling, with a 7% slope, and soil types are light clay and sandy loam, subject to erosion. Terraces are laid out about 150′ apart on this field to control runoff and prevent erosion.

Soil Conservation Service personnel lay out the terraces, and Bailey works the earth as illustrated here.

FIRST PASS

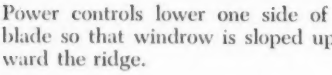
Channel is cut flat and the windrow is angled to the ridge side (see sketch). Second pass deepens the channel cut and piles more dirt on the windrow. Cutting the terraces is usually done in 2nd gear.

THIRD PASS



Power controls lower one side of the blade so that windrow is sloped up toward the ridge.

FOURTH PASS



Motor grader backslopes into the terrace channel. The windrow will be picked up and laid on the ridge on the fifth and sixth passes.

SEVENTH PASS

Cut is made on the outside slope, low side of the ridge.

EIGHTH PASS

Another cut is made from the center of the channel, leaving a windrow on the ridge side.

FINISHING PASSES

Windrow is smoothed out on top of the ridge.

This terrace is one of many types used in the U.S.A. Accepted terrace designs result from conditions and experiences in each locality. However, conservation contractors like Ernest Bailey find a Cat Motor Grader to be the most versatile and productive machine for a wide variety of terrace building jobs.

Here's how Mr. Bailey feels about it:

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One in a series of technical reports by Bower

BEARING BRIEFINGS

ROLLER GUIDANCE— VITAL FACTOR IN BEARING LIFE

Roller guidance has been established by the Anti-Friction Bearing Manufacturers Association as a major rating factor for roller bearings. There is a direct relationship between this factor and the life and capacity of a cylindrical roller bearing under load.

Figure 1 illustrates the results of a loose fit between a roller and the guiding ribs of the raceway. Because of lack of guidance by the ribs, the roller is free to skew and skid under load. Such a condition invariably leads to early bearing failure.

To achieve close roller fit and proper roller guidance, Bower precision grinds each bearing race on specially designed centerless grinders. In this operation, Bower positions the integral raceway ribs *from the theoretical centerline of the bearing*. This method produces bearings with high dimensional accuracy and perfect symmetry.

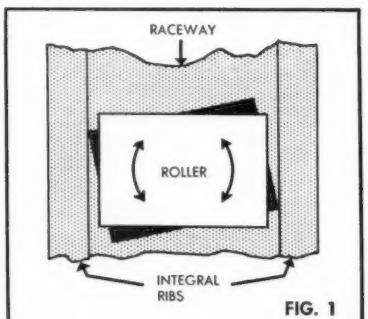
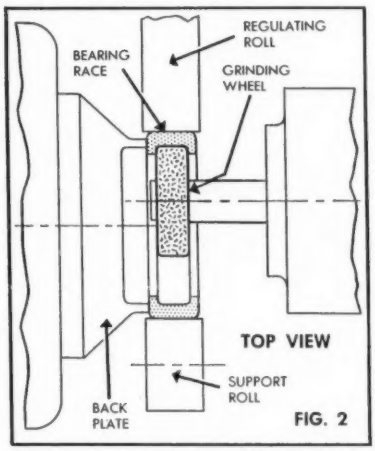
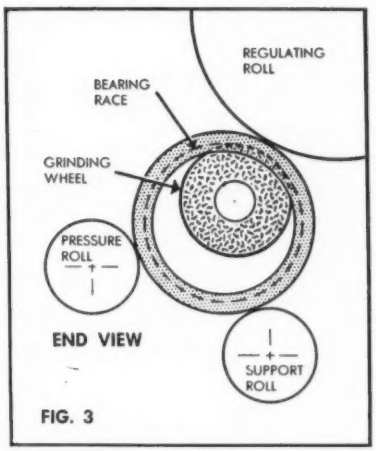


Fig. 1. Loose fit in raceway means poor roller guidance. Roller can skew and skid under load.

In addition, the close tolerances held in grinding the roller track and integral guiding ribs give Bower cylindrical roller bearings the ability to *take thrust in any direction*. A Bower cylindrical roller bearing has thrust capacity of from 10-15% of its rated radial capacity!



Figures 2 and 3 diagram the centerless grinding method used to finish Bower raceways. Use of this technique assures not only optimum roller guidance and maximum bearing life, but also virtually eliminates bearing runout. BEARING SYMMETRY WHICH RESULTS FROM THIS TECHNIQUE PERMITS ACCURATE SHAFT LOCATION REGARDLESS OF HOW THE OUTER RACE AND ROLLER ASSEMBLY ARE INSTALLED. IT COMPLETELY ELIMINATES THE POSSIBILITY OF IMPROPER INSTALLATION.



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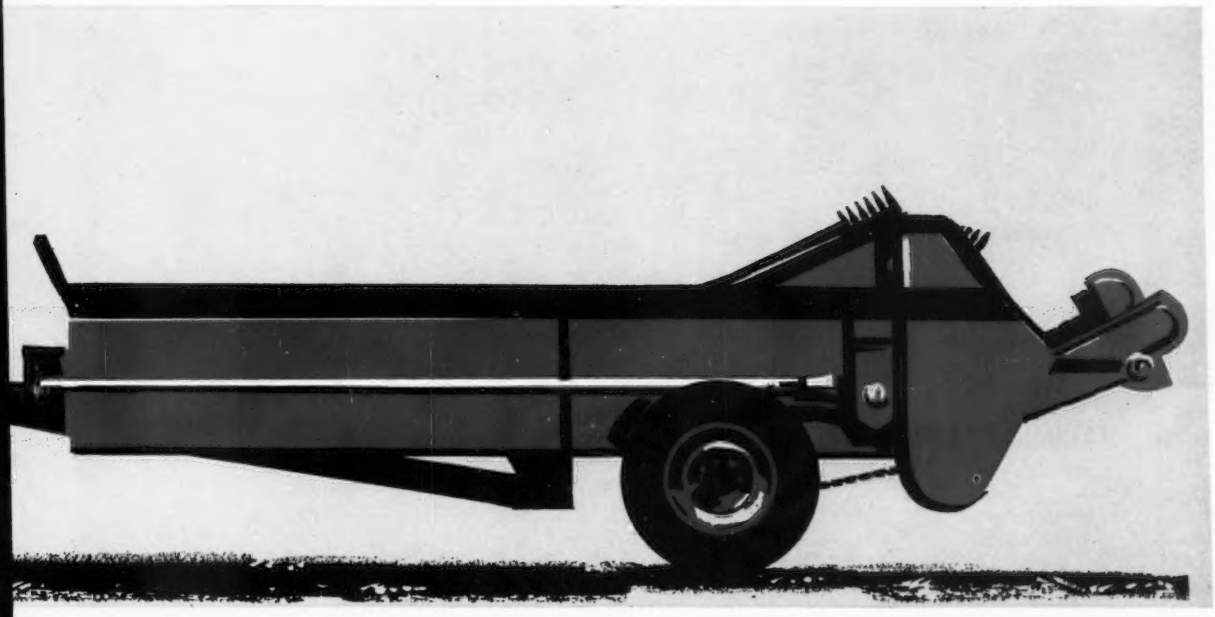

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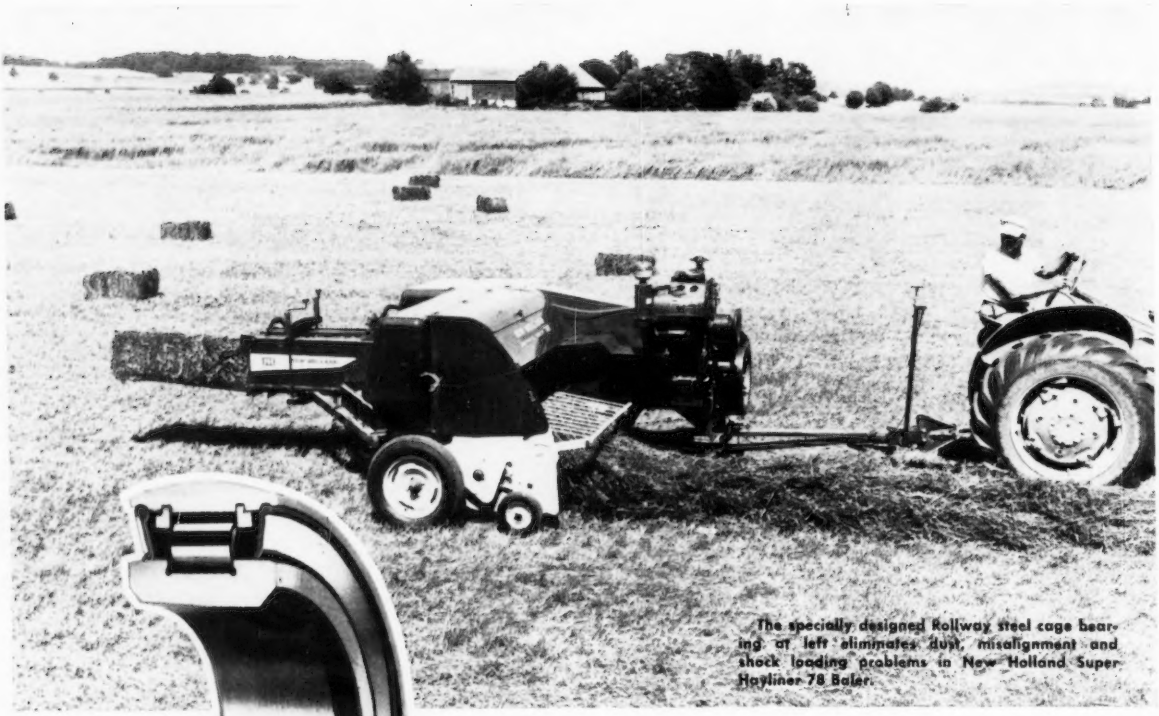
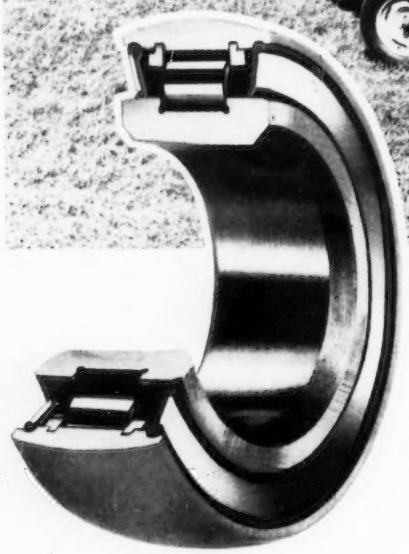


The specially designed Rollway steel cage bearing at left eliminates dust, misalignment and shock loading problems in New Holland Super Hayliner 78 Baler.



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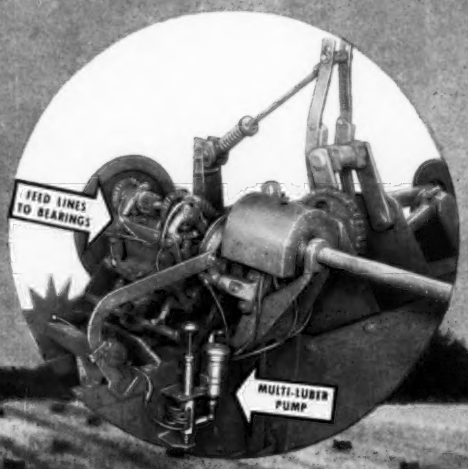

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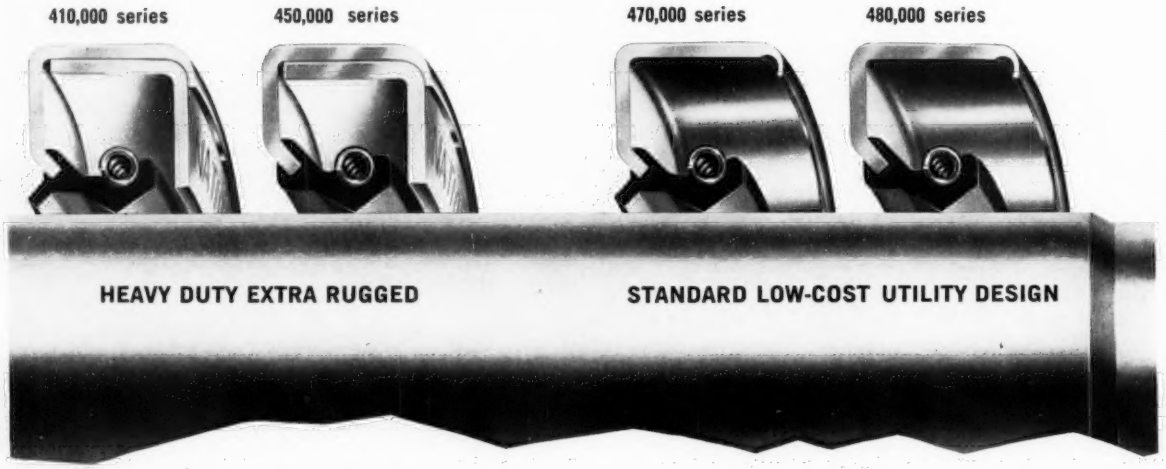

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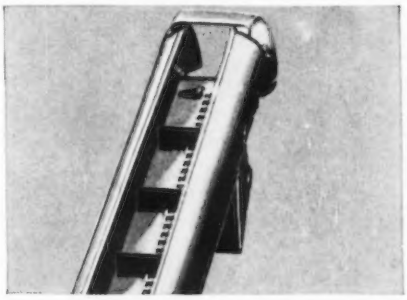

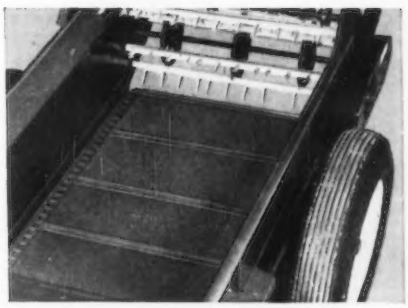

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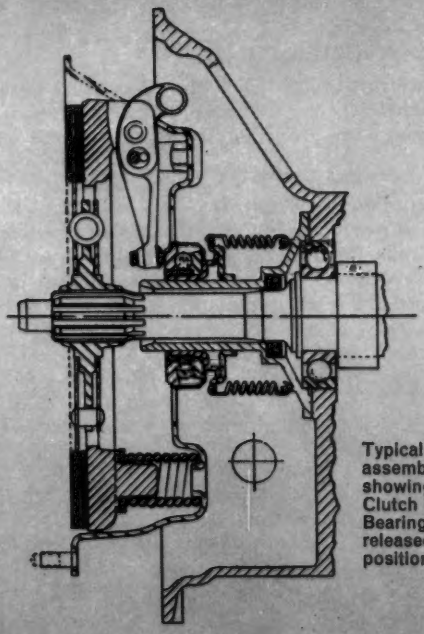
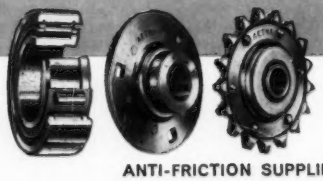


Typical clutch assembly showing Aetna Clutch Release Bearing in released position.



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Agricultural Engineering

February 1960
Number 2
Volume 41

James Basselman, *Editor*

ASAE WINTER MEETING COUNCIL ACTION

DURING the 1959 Winter Meeting the Council of ASAE decided that a thumbnail sketch or resume of pertinent Council actions should be reported in AGRICULTURAL ENGINEERING after each meeting in order that the general membership might have a better understanding of the discussions and deliberations carried on in their behalf by their elected representatives. Following is an account of the matters that were acted upon during the Council sessions held before and during the Winter Meeting in Chicago, December 14 through December 18, 1959:

President L. H. Skromme, in his opening remarks reviewed his activities as Society president during the past six months. In addition to reporting on considerable travel in which he visited the North Atlantic, Tennessee, Ohio, Pacific Northwest, Virginia and Washington (D.C.) Sections he reported that the new public relations committees had been appointed, that the forward planning committee had been organized, and that considerable work had been done toward preparation of a letter to industry executives concerning finances for the ASAE motion picture. He also called attention to the report of Society's committee on student recruitment and emphasized the need for a more positive program to interest high school students in the career opportunities offered by the agricultural engineering profession.

Following the ASAE headquarter's report by staff members, which dealt at length with publications, membership, finances, public relations, advertising, technical and promotional activities, etc., the following business was conducted:

The report of ASAE observer to the Engineers Joint Council covered (a) plans for an EJC-produced "unity" publication for the engineering profession, (b) proposed amalgamation of ECPD and EJC, (c) recently adopted procedure of exchanging meeting privileges among member societies, (d) proposed EJC exhibit and activity in connection with the 1964 World's Fair in New York, (e) activities of EJC with respect to international affairs, nuclear congresses, etc., and (f) proposal that the president or executive secretary of EJC be invited to speak at an ASAE national meeting in order to acquaint the full Society membership with the purpose, function, and objectives of EJC. It was subsequently recommended that a similar discussion be made by someone qualified to describe the National Academy of Science, National Research Council and ECPD

The possibility of ASAE's sponsorship of commercial exhibits in connection with its Winter Meeting was discussed. Additional income, educational value, and possibility of increased meeting attendance, were factors given in support of exhibits. Adverse opinions expressed were necessity for changing the character and format of the meeting and possibility of exhibit activity competing with or dominating technical sessions. Following discussion it was moved that commercial exhibits in connection with ASAE Winter Meetings be dropped for the present. The possibility or feasibility of a special conference on farm machinery design was brought up, which might serve as a more appropriate place to sponsor exhibit activity. This would offer the advantages mentioned above but yet would not obligate the Society by setting a precedent, such as would be the case if exhibits were sponsored in connection with the Winter Meeting. No action was taken.

Reorganization of ASAE sections into "regions" and "chapters" was discussed. It was resolved that modification to the section organizational setup should originate with the sections themselves, but that the situation and some of the possibilities might be brought to the attention of the section officers at the next Cabinet meeting.

In an effort to strengthen the professional activities of the local sections and of agricultural engineering in the mid-South area, it was decided to hold the 1960 ASAE Winter Meeting in Memphis, Tennessee, December 5-7, 1960, on a one-year trial basis with possible future meetings held away from Chicago every fourth year.

This action was taken after 1961 meeting dates at the Palmer House Hotel had been confirmed and approved and a tentative acceptance had been given Palmer House Hotel for 1962.

Financial arrangements for the Memphis meeting, consideration of ASAE participation in CIGR and an International Congress of Agricultural Engineering, consideration of a proposed code designation for ASAE committees, and approval of a plan to transfer affiliate members of student branches into ASAE as Affiliate members on the same *financial* basis but following normal election procedures, were handled as items of business.

Other reports received were: A report of the Finance Committee, a need for assistance in handling technical requests directed to ASAE headquarters; and a report of the special Committee on Student Recruitment which projected a decreasing enrollment trend in agricultural engineering and listed a number of steps which might be taken by various groups and subdivisions within the Society to reverse the downward trend.

Further study of group insurance for ASAE members was tabled.

A new procedure for appointment of division committees directly by division chairmen was discussed and it was decided that a draft of proposed amendments to Society's By-Laws covering the recommended changes be submitted for further consideration by the Council.

A request for permission to schedule another Conference on the 4-H Electric Program in conjunction with the 1960 Winter Meeting of ASAE was granted. An ASAE exhibit at the Technorama on Agricultural Engineering at Michigan State University was authorized; and a committee was authorized to study possibilities of an ASAE-sponsored monograph series.

The McCormick, Deere, and MBMA Awards recipients for 1960 were reported and the Jury action was approved by the Council.

Other items acted upon were: Discussion of certificate of service for division chairmen; voted not to sponsor Seventh National Watershed Congress; authorized increase of Finance Committee membership from 4 to 5 members; established a Society Committee on Standards; approved organization of a Committee on Rural Waste Disposal; appointed H. H. Nuernberger as ASAE representative to Engineers Joint Council; and requested a review of the letter of instructions to ASAE Nominating Committees.

Society members having pertinent comments concerning any of these actions are encouraged to submit them directly to members of the ASAE Council shown on table of contents page of this issue, or to the executive secretary of ASAE.

ASAE 53rd Annual Meeting • Ohio State University, Columbus, Ohio • June 12-16

Drying Rate of Alfalfa Hay

T. T. Pedersen and W. F. Buchele
Assoc. Member ASAE Member ASAE

This determination of the drying rate of alfalfa hay serves as an introduction to an article entitled "Hay-in-a-Day Harvesting" to be carried in the March issue

DURING the time interval of cutting hay until the forage has dried to storable moisture content, normally 20 percent (wet basis), a progression of events takes place which promotes losses and deterioration of quality and feeding value of hay.

Freshly cut forage is a living material, since the plant cells continue respiration and plant enzymes are active as long as air is present and there is sufficient moisture available. Losses of dry matter amounting to 5 to 15 percent of the total crop have been found to occur from these fermentation losses during normal field drying.

Besides this fermentation loss, the loss of leaves is dependent on the anatomy, physiology and mechanical handling of the alfalfa plant. With conventional methods of harvesting hay — cutting, conditioning, windrowing, raking, and baling — at least 20 percent of the leaves are lost. This figure is much larger when the hay receives one or more rains while still in the field. In this connection, it should be stated that approximately 70 percent of the protein and approximately 90 percent of the carotene are contained in the leaves of the plant.

A new hay-harvesting method which would decrease fermentation and leaf loss is desired. This method should, as much as possible, take advantage of the anatomy and physiology of alfalfa. This is the first of two articles on increasing the drying rate of hay.

Anatomy and Physiology of Alfalfa Leaves

The alfalfa leaf is covered with a single layer of cells, generally called the epidermis, and is somewhat cutinized, and for that reason more or less impervious to water vapor. Under the epidermis is the thin-walled parenchyma tissue through which numerous finely divided vascular bundles permeate and end free in the epidermis so that there are thousands of these veins in each square inch of leaf surface.

The epidermis of the leaf, however, is not completely intact, but is perforated by numerous pores called stomata. They are intercellular openings between two especially formed epidermal or guard cells. The parenchyma tissue of the leaf is very loosely constructed so that there are many air spaces between the cells. These intercellular spaces join with one another and finally unite with one of the large air spaces directly beneath each stoma.

In the guard cells the wall of the cell is much thinner where it borders on the epidermal cell than on the opposite side next to the stoma. When the turgor pressure of the cell is increased this thinner wall is stretched out further than the other and pulls the thicker wall bordering the stoma. This increases the size of the pore.

The Number of Stomata

The number of stomata developed per unit area depends on different weather factors such as relative humidity, the intensity of sunlight and probably some other factors.

Mariana (5)* studied the effect of the humidity in the air upon the development of stomata. He came to the conclusion that the humidity favors the development of the superficial areas of the leaves, but it does not increase the absolute number of stomata. Reed and Hirana (7) found that the density of stomata was decreased when the intensity of light was reduced.

Miller (6) has studied the number of stomata per square inch of various agricultural plants and found that the average number for the upper surface of alfalfa leaf to be 680,000 and for the lower surface 550,000 per square inch. Thus the total number of stomata per square inch is some 1,235,000. In spite of the high number per unit area, the area of the stomata is only one to three percent of the leaf surface.

Opening and Closing of the Stomata

The stomata on the upper surface may behave differently from those on the lower. That is, those on the lower surface open more slowly and close earlier than those on the upper. On all the leaves there are a certain number of stomata that are functionless, while others are more or less inactive.

Different factors such as light, temperature, humidity and moisture cause the opening and closing of the stomata. The drying rate in hay may be increased by keeping the stomata open. For alfalfa, there is a daily cycle of opening and closing of these stomata.

Loftfield (4) found that the stomata of alfalfa under favorable conditions are open all day and closed all night. They open two to six hours after daybreak and remain open three to six hours and then gradually close over a period about twice as long as that required for opening. When the conditions become less favorable for moisture, the stomata close partially for a time during the middle of the day; this period of midday closure increases to complete closure as the conditions become less favorable. With the appearance of midday closure, night opening develops and increases with the increase of day closure, until finally

Paper presented at a meeting of the Michigan Section of the American Society of Agricultural Engineers at Detroit, Mich., February 1959. (This article is based on a master of science thesis by Mr. Pedersen entitled "The effect of conditioning and physical environment on the field drying of alfalfa," and is authorized for publication as Journal Article No. 2447 of the Michigan Agricultural Experiment Station.)

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Authors' Note: The authors appreciate the assistance of the National Academy of Science and the International Cooperative Administration in supporting the study reported in this paper.

*Numbers in parentheses refer to the appended references.

there is partial opening of the stomata all night and a complete closure all day.

This means that the opening and closure of the stomata is controlled by so many factors that it hardly can be relied upon for selection of the optimum time of day for mowing the alfalfa.

Transpiration from Living Plants

It is generally known that all living plants require water for their existence and development, and that the plants use it in considerable amounts. Most of the water absorbed from the soil, however, takes no permanent place in the development of the plant or the metabolic process. Of the water absorbed from the soil, 98 to 99 percent escapes from the plant by transpiration in the form of water vapor. The greatest part of this transpiration takes place through the stomata-stomatal transpiration. Only approximately 10 percent of the water vapor is lost from the leaves and stems by direct evaporation from the cuticle.

All of the living cells within the leaves are filled with liquid water, and evaporation takes place from the wet cell into the intercellular spaces. If the stomata are closed, the evaporation from the cell wall will stop when the entire volume of the air of the intercellular spaces reaches 100 percent relative humidity. When the stomata are open, diffusion of water vapor occurs through them into the atmosphere outside the stoma, unless the atmosphere has a vapor pressure equal to or greater than that in the intercellular spaces.

Such factors as temperature, relative humidity and wind affect the transpiration rate. As the temperature rises, in general, the rate of transpiration increases. Briggs and Shantz (1, 2) concluded that in the case of alfalfa the transpiration graph rose in advance of the temperature in the forenoon; however, in the afternoon the transpiration always fell off more rapidly than the temperature. When the transpiration had reached its night level, the temperature was still above the minimum by about one-third the daily range.

Thomas and Hill (8) found that the rate of transpiration from a six-foot square plot of alfalfa in grams per hour ranged from 200 to 300 grams during the night to a maximum of 3,000 grams about 2 p.m. The rate of transpiration begins to rise from night time low at 6 a.m. and reaches nearly the same level after the afternoon high and decreases to the nighttime level by 8 o'clock in the evening.

In general, it is known that a decrease in the relative humidity causes a higher transpiration rate. Darwin (3) found that the relation between relative humidity and the transpiration rate, in general, is linear. He also discovered that the transpiration rate is not zero in saturated air, which means that the vapor pressure in the leaf is higher than that of saturated air.

The effect of wind depends upon the wind velocity. In the first place, the winds tend to remove the blanket of more or less saturated air surrounding the leaves. This tends to decrease the distance the water vapor must travel to find free air conditions. If the wind velocity is too high, some of the stomata may close and the rate of transpiration stops increasing and may begin decreasing. The conclusion of all the experiments conducted concerning the influence of wind on the transpiration can be stated as follows: the water loss from most living plants does not increase as the wind velocity increases above a gentle breeze.

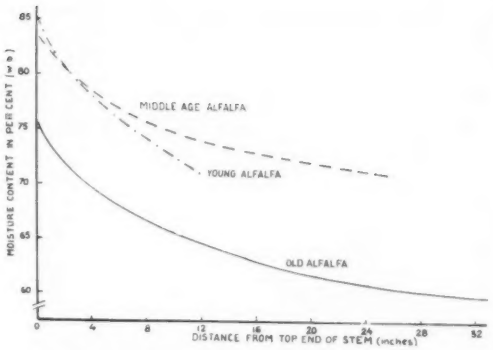

Fig. 1 Moisture content of alfalfa stems of various ages

Distribution of Water in Green Alfalfa

From research in plant physiology, it is well known that actively growing sections of the plant, such as growing stems, root ends, flowers and leaves utilize a considerable amount of water. It has not been possible, however, to find any exact figures concerning the distribution of water throughout the entire plant of alfalfa.

The distribution of water in the plant was determined for the alfalfa plant at three different ages: *(a)* young alfalfa plants in prebloom stage, *(b)* alfalfa in one-tenth bloom stage (normal maturity for hay), and *(c)* old alfalfa plants past full bloom (one-fourth seed pods).

The results of this experiment are shown in Fig. 1 and Table 1. The curves indicate that the decrease per unit length was considerably larger near the top end than in the lower stem part. The lowest moisture content of all plants was near the root. It was 60 percent in old plants and 72 percent in middle-age and young alfalfa. The average moisture content for old, middle-age and young alfalfa was 65.3, 73.7 and 77.3 percent, respectively.

The highest moisture content was found in the growing section of the plant. In the stem just below the heads the moisture content in young and middle-age alfalfa was found to range from 83.5 to 85.5 percent. In old plants the moisture content at the same place was something lower, about 76 percent.

Table 1 shows that the moisture contents in heads as well as leaves decreases with the age of the alfalfa plant. (The younger the plant, the more undeveloped the leaves and the heads.) The results in Table 1 thus correspond with those found in the analysis of the stems, where it also was found that the growing parts had the highest moisture content.

TABLE 1. THE MOISTURE CONTENT IN LEAVES AND HEADS OF ALFALFA

Age	Moisture Content	
	Leaves	Heads
	Percent (wet basis)	
Old alfalfa	64.4	68.2
Middle-age alfalfa	70.8	80.2
Young alfalfa	77.1	—

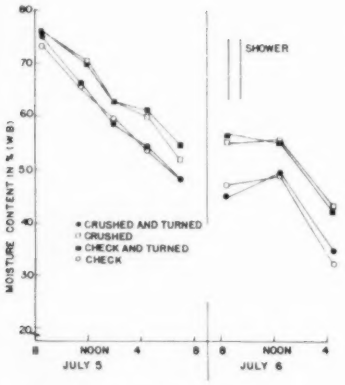

Fig. 2 Drying curves for alfalfa hay where part of the hay swath was turned upside down

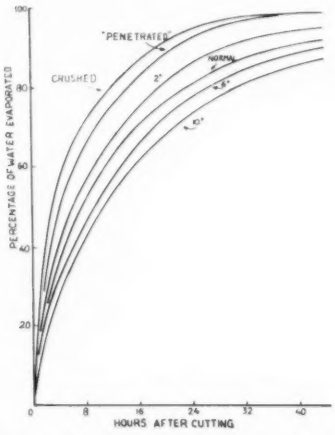

Fig. 3 Drying curves for alfalfa plants treated in different ways

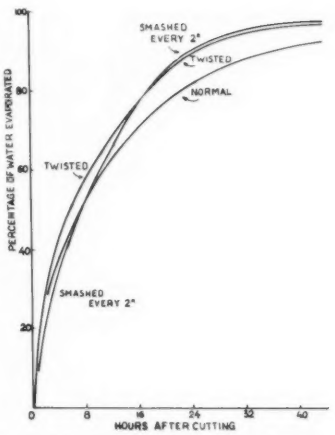

Fig. 4 Drying curves for alfalfa plants treated in different ways

Equalizing Drying Rates

It is an observed fact that alfalfa leaves dry faster than the stems. In order to decrease this difference in drying rate, an experiment was initiated in which part of the hay swath was turned upside down. Such an inversion of the swath caused most of the stems to be placed on the upper side of the swath, where they were exposed to sun, and wind, and the leaves were shaded by the stems. This experiment was conducted on crushed and uncrushed alfalfa hay. Half the swath was turned upside down immediately after cutting and crushing.

The results of this experiment are shown in Fig. 2. The data indicated that crushing of the alfalfa plant increased the drying rate, whereas turning of the swath did not influence the drying rate. The irregularity of the curves between 8:30 a.m. and noon on July 6 was due to the fact that some of the samples were collected before the rain started (indicated on the diagram) and some were collected during the first ten minutes of the rain. All the samples from the crushed hay plots were taken before the rain started. For this reason the moisture content increased in the crushed samples between 8:30 a.m. and noon. The uncrushed samples were already partly wetted by the rain when they were bagged, hence there was little or no increase in moisture content in these samples.

A second experiment was conducted in which one-third of the crushed and uncrushed swath was left unturned, one-third was turned immediately after cutting, and one-third was turned after four hours of drying in the swath. Again no increase in drying rate was secured by turning the swath.

Treatments to Promote Rapid Drying

The anatomy and physiology of alfalfa was studied to determine ways of increasing moisture loss. This study showed that one of the ways of increasing the rate of evaporation from alfalfa was to break the cuticle. This layer covers stems as well as leaves and consists of cutinized cells impervious to water vapor. It is more important, however, to break the cuticle on the stems than that on the

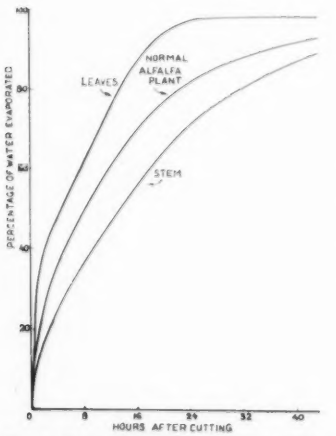

Fig. 5 Drying curves for normal alfalfa plants when leaves and stems are dried separately

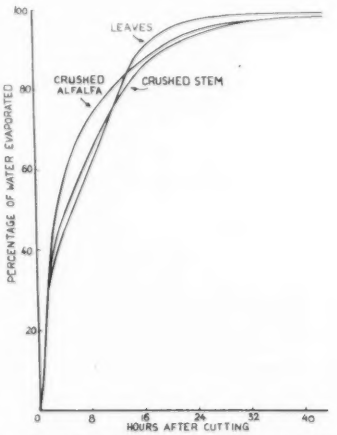

Fig. 6 Drying curves for crushed alfalfa when leaves and stems are dried separately

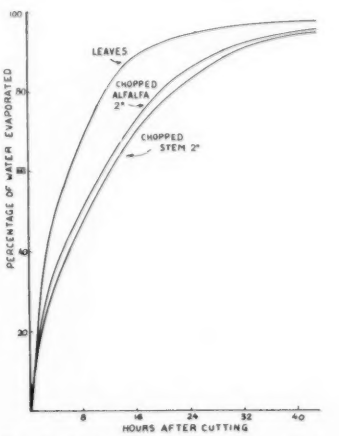

Fig. 7 Drying curves for chopped alfalfa (2 in.) when leaves and stems are dried separately

leaves which have the stomata as natural openings for transpiration.

The following treatments were applied to alfalfa plants:

(a) Alfalfa plants cut in 2-in. pieces
(b) Alfalfa plants cut in 6-in. pieces
(c) Alfalfa plants cut in 10-in. pieces
(d) Crushing of the plant (crushing more severe than normally done by commercial hay crushers)
(e) Stems smashed every 2 in. in a length of ¼ to ½ in.
(f) The surface broken by twisting the stems
(g) The surface broken by penetrating the stem several places every inch by means of a thin nail
(h) Normal alfalfa plants with no treatments.

All the plants were of the same maturity, the same length, and were cut at the same time. In order to get uniform drying conditions throughout the experiment, it was conducted in a controlled atmosphere – 84 deg F and 68 percent relative humidity.

The results of the experiments are shown in Figs. 3 and 4. The curves of chopped hay indicate that chopping of alfalfa in short length (2 in.) immediately after cutting increased the drying rate. The long cuts required longer drying time than the check. The highest rate of drying occurred when the hay was crushed, but nearly the same rate was obtained when the surface was "penetrated." Smashing of the stems every 2 in. and twisting them were nearly equal in regard to increasing the drying rate but not as effective as hard crushing or "penetrating" of the stems.

Table 2 shows the time required for the different treatments to reach a moisture content of 20 percent (wet basis).

TABLE 2. TIME IN HOURS REQUIRED TO REDUCE THE MOISTURE CONTENT OF HAY TO 20 PERCENT

Treatments							
Check	Penetrated	Smashed	Twisted	Crushed	2 in.	Chopped 6 in.	10 in.
45	22	28	29	20	36	48+	48+

In referring to this table it should be remembered that this research was conducted in constant room temperature at high relative humidity. On a good haying day the drying conditions are better and should result in a shorter drying time.

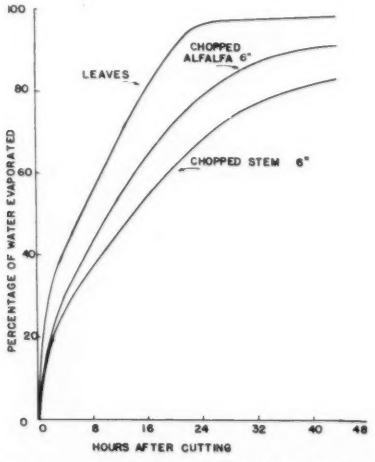

Fig. 8 Drying curves for chopped alfalfa (6 in.) when leaves and stems are dried separately

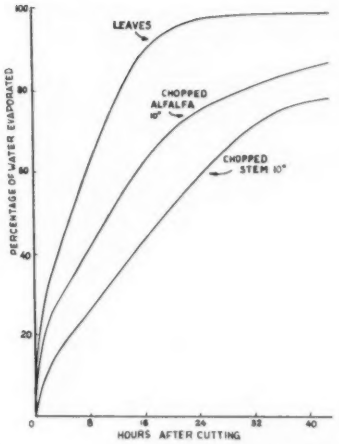

Fig. 9 Drying curves for chopped alfalfa (10 in.) when leaves and stems are dried separately

Differences in Evaporation Rate

Under normal curing conditions the leaves dry much faster than the stems (9). Research has shown that, when the crop has dried to an average moisture content of 30 percent (wet basis), moisture content of the leaves will be at approximately 25 percent and the stems, approximately 35 percent moisture. This differential in drying rate increases field-drying time and results in considerable loss of leaves and even a greater decrease in feeding value of the hay.

In order to determine the influence of the different treatments on the rate of evaporation from leaves and stems separately, an experiment similar to the previous experiment was conducted. In this case, the leaves were separated from the stems immediately after the treatments were finished. The treatments were the same as in the previous experiment.

The evaporation curves obtained from this research are shown in Figs. 5 through 11. They indicate that only when the stem surface was nearly disintegrated (hard crushed or penetrated), did the rate of evaporation from the stems approach that of the leaves.

The drying curves for leaves showed high evaporation during the first and second hour after cutting; in the third hour of drying the evaporation rate was lower but still of considerable amount. An average of 43.6 percent of the total water was evaporated during the first three hours after cutting. Between three hours after cutting and the time equilibrium moisture was reached, the evaporation rate (slope of curve) was nearly constant and considerably less than during the first hours of drying.

The constant decrease in drying rate in leaves from 1½ to 3 hr after cutting may be the result of the loss of surface openings caused by progressive closing of stomata. After three hours of drying, the evaporation takes place only through the cuticle and possible wounds caused by mechanical treatments. On account of this and the fact that alfalfa leaves are very thin, it seems reasonable to believe that the rate of evaporation is nearly constant until the moisture content reaches the point of equilibrium.

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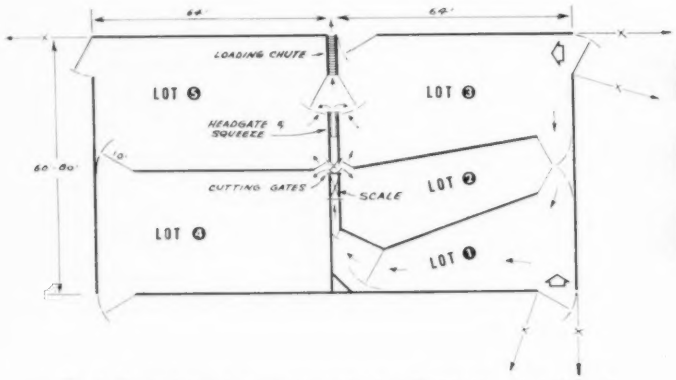

Fig. 1 Typical corral arrangement for handling large cow-calf herds

Mechanizing Large-Scale Beef Production

Arthur H. Schulz

Operations designed for efficiency and economy of feeding, handling, and use of labor and capital

LARGE livestock herd operations are basically meat production factories. Industry long ago learned the need for complete production control with facilities for production regulation, inspection, checking and rejecting, and for exact control of capital and of operations requiring labor. Livestock production programs, particularly with larger herds, have adapted, or are rapidly adapting, these same production standards. The day of the cowboy with his rope, except under special conditions, and the day of hand handling and feeding, are rapidly approaching oblivion. Operations are being designed for efficiency of feeding, ease of handling, economy of labor and efficient use of capital. It is in the last three respects that the engineer has a major responsibility.

Large livestock operations have high capital requirements, frequently so high as to require a corporate or cooperative financial structure to provide the necessary financing. Utilization of this capital to help assure satisfactory returns on the investment is a challenge to every engineer who must design these modern beef factories.

The field of beef production, particularly with larger herds, can be divided into two general groups, the cow-calf and the feeder operation. The handling of livestock in each type of operation requires special considerations.

Cow-Calf Beef Herd

The cow-calf operation is basically a grazing or roughage feeding-grazing combination. This type operation requires a bare minimum of equipment and housing. Natural protection as a substitute for sheds is normally utilized to a maximum degree. Mechanization of the operation is generally confined to the handling of roughage, both with respect to field production and to processing and feeding operations.

Large volumes of roughages are required in some areas for wintering the herds. The relative total costs of handling roughages by the various available methods must be carefully considered when designing the system. North Dakota ranchers are rapidly adopting the hay-stacking frame, stack mover and hydraulic loader with the grapple-fork method of handling all hay from the field to the cow. A three-man crew using this method can stack from 40 to 60 tons of hay per day. Assembling the stacks and feeding, using the stack mover and hydraulic fork, becomes a one-man job if the layout of the lots is designed for this type of hay handling. Storage space and gate arrangement, or rather elimination of gates, are all major considerations in design.

Equipment for Cow-Calf Operation

Handling facilities for sorting, branding, dehorning, spraying, veterinary services, weighing and similar tasks are vitally important. The design for a handling system for a cow-calf operation requires the following special considerations: *(a)* It is convenient to be able to handle large numbers of cows and/or calves at one time; therefore, the pens in the corral arrangement must be larger than for a feeder operation. *(b)* Animals may be range wild, so special assembly and holding areas must be provided. Also, the fencing must be high enough (6 ft) and tight enough to prevent climbing, and sturdy enough to withstand crowding. *(c)* Animals varying from a 150-lb calf to a 1,200-lb cow must be worked from the same basic unit. *(d)* Separation may have to be made into four or more separate lots with each lot to be held separate until moved to permanent locations. *(e)* Complete control of each animal must be maintained with a minimum of effort until all operations have been completed.

No single layout will meet the special requirements of each ranch headquarters. The layout shown in Fig. 1 is a typical working corral that has proved satisfactory. In this arrangement, cattle can be assembled in holding areas outside lots 1 or 3. They can then be brought into the working areas in these lots. If started in lot 1, they can be worked down to lot 3 from where they can be worked through the chute arrangement and into any one of lots 1,

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The author — Arthur H. Schulz — is extension agricultural engineer, North Dakota Agricultural College, Fargo.

2, 4, or 5, thus giving adequate opportunity for sorting, holding and handling. Any one of these four lots can be further subdivided for additional control. Many other types of handling arrangements can be used. The circular-type corral is particularly satisfactory for straight separation of herds into lots. The circular corral eliminates the long working chutes that are required for rectangular corrals. All corral arrangements should have the same general objective of easily working the cattle. Location of the chute, cutting gates, headgate and squeeze and loading facilities must all be based on this objective.

Production Testing in Cow-Calf Herds

Production testing of beef herds to establish productive capacities of cows and bulls presents special problems to the designer. This practice is being accepted by an increasing number of cattle men. This program requires the pairing off and numbering of the cow and her calf at calving time. The calf is then weighed at weaning time. This weight is a partial means of determining the productive capacity of the cow and/or the sire. Where this program is in effect, facilities must be provided for easily and rapidly identifying and weighing each calf individually and later sorting the cows on the basis of their productivity.

The individual scale, either portable or fixed, installed with gates in the working chute, permits the handling of cattle at rates in excess of 100 per hour with crews of three to four men. Twelve to 16 feet of chute between the end of the squeeze pen and the scale speeds the operation by having two or more calves in the chute ready for weighing at all times. Where the initial division of calves from cows is made in the chute, it is advisable to install the scale between the cutting gates and the headgate instead of ahead of the cutting gates.

The practice of providing simple handling facilities strategically located around pastures to permit easy working of cattle without returning them to headquarters is frequently neglected. A simple funnel-shaped holding area (Fig. 2) with crowding facilities, chute, headgate, and loading facilities will save many pounds of beef lost in trailing cattle to a central handling facility. This same type of facility will prove very valuable for identification activities in production testing programs.

Beef-Feeding Operations

Beef feeding has become big business. Lots with 1,000 to 2,000 feeders each have become commonplace. Feedlots are now in operation with more than a 20,000 animal capacity. These units are truly beef factories with production-line methods.

Many small feeding operations are based on the use of farm-produced feed and use of excess or available farm labor. Large feeding operations are usually the basic business and are operated independently of other farming operations. This point is a consideration in feed handling, planning, layout and operation of the feeding units.

Mechanization of Beef-Feeding Operations

Complete mechanization of feed handling must be provided for in large operations. Feed costs represent 65 to 80 percent of the total cost of beef production. The present activity in the development of pelleting, wafering and other methods that will permit greater mechanization of feeding operations are of major importance to the feeder. Equipment costs for these operations are high. Operation costs are also substantial. Cost benefit ratios for this equipment must be considered when designing a feed-handling system around this type of mechanization. Because feed represents a high percentage of the total costs, feed efficiency and rate of gain from a feeding system may be of greater importance than the method of feeding used. In some instances, feeding methods may actually increase feed efficiency. Results of feeding trials performed by animal husbandrymen should be watched closely by engineers as they may affect design recommendations.

All feedlot layout design for large herds must include provision for multiple lots to accommodate variations in animal size, quality, rate of gain, ownership and other factors. The most satisfactory lot size appears to be one that will accommodate about 200 head with the lots arranged in a rectangular pattern (Fig. 3). Mechanization using augers, drags, shuttles or similar conveying equipment must be considered when planning feedlots with four or less individual pens. As the number of individual pens increases, the problems of conveying, ration mixing and separation and cost of installation frequently eliminate this type equipment.

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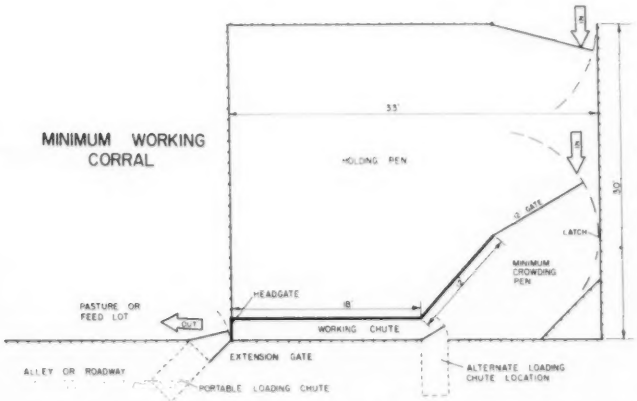

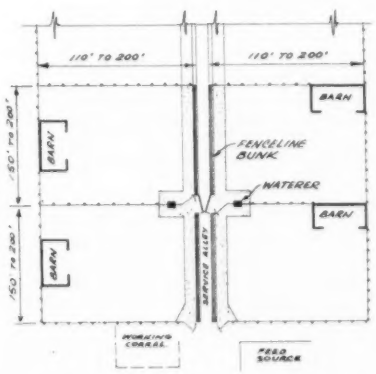

Fig. 2 *(left)* Small funnel-type corral for handling cattle • Fig. 3 *(right)* Typical rectangular layout for multiple pens in large feedlot installations

Influence of Particle Movement on Energy Losses in an Impeller Blower

William J. Chancellor
Assoc. Member ASAE

Source of forage blower inefficiency examined by analysis and experiment

PARTICLE movement through the impeller blower has been approached analytically by several researchers (2, 3, 6, 10)* and experimentally by some of these and others (1, 3, 7).

The power requirements of forage blowers have been measured by many researchers in investigations aimed at understanding why mechanical efficiency is so low (1, 2, 4, 7, 8, 9). The general conclusion is that the low efficiency is related to undesirable particle movement, especially the condition where particles are not fully released from the impeller before striking the cutoff.

Analysis

The analysis of power requirements is commonly made using an energy balance. Sometimes only two items appear as output: *(a)* energy for air movement and friction, and *(b)* kinetic energy of the escaping particles (usually assumed at a velocity equal to the tangential speed of the impeller). Such balances can be refined by considering two other items *(a)* the energy absorbed by the particle in passing radially through the centrifugal field, which energy is then dissipated as the particle strikes the housing and *(b)* the energy required to overcome the reduction in tangential velocity due to friction during the impact of the particle with the housing. This first item can be shown to be equal to:

$$\text{Weight} \times (V_{\text{tangential}})^2 \times 1/2g \quad (2, 6).$$

If the radial velocity just before collision is known, the second item may also be computed. Kampf, in an article which contains several mathematical analyses of impeller blower phenomena (6), presents a method for computation of radial velocity, the results of which can be crudely approximated by

$$V_{\text{radial}} = (V_{\text{tangential}}) \ (1-0.7f) \quad . \quad . \quad . \quad [1]$$

where f is the coefficient of friction. If the collision is considered to be inelastic (the material compressing without rebound), the radial velocity will be equal to the velocity change $m \Delta V = \int F \, dt$.

where m = mass in slugs

ΔV = change of radial velocity in feet per second

F = force in pounds

dt = the differential of the time interval for radial deacceleration to occur.

Friction energy loss equals

$$(\int F \, dt) \times f \times \frac{ds \text{ tangential}}{dt}$$

where s = distance in feet.

Thus friction energy loss equals

$$m \times V_{\text{radial}} \times f \times V_{\text{tangential}}$$

For one pound, $\frac{1}{g} V_{\text{radial}} \times f \times V_{\text{tangential}}$

equals the specific friction energy loss. Combining with the above approximation, friction energy loss equals

$$\frac{1}{g} (V_{\tan})^2 \ (f) \ (1-0.7f) \quad . \quad . \quad . \quad . \quad . \quad [2]$$

For the following friction coefficients, the specific friction energy loss in proportion to the specific energy of the particle moving at the tangential velocity is as follows:

f	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1
$\%\frac{(V_{\tan})^2}{2g}$	70	71	70	65	58	47	34	19

This means that, if the coefficient of friction of the particle against steel is 0.6, the minimum energy required to accelerate one pound of material to $V_{\tan}$ is equal to

tangential kinetic energy, plus
energy of passage through centrifugal field, plus
frictional energy loss,

equals $(V_{\tan})^2/2g + (V_{\tan})^2/2g + 0.7 \ (V_{\tan})^2/2g$
$= 2.7 \ (V_{\tan})^2/2g.$

Kampf presented a method for computing angle of discharge when the particle does not strike the housing but is released into the pipe opening. Representative values for an impeller with radial paddles range from 43 deg left of vertical to 45 deg right of vertical.

For this case and all other cases where a free-flying particle strikes an inclined plane, an analysis is presented here to describe the losses in kinetic energy.

Assuming an inelastic collision and all directions in the horizontal plane, the initial velocity of a particle, V_o, can be resolved into a velocity perpendicular to an inclined plane and one parallel to it (Fig. 1). The initial energy loss in

Fig. 1 Resolution of particle velocity into components perpendicular and parallel to an inclined plane

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First part of a three-part paper presented at the Winter Meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 1959, on a program arranged by the Power and Machinery Division. (The second and third parts will be published in the March and April issues.)

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*Numbers in parentheses refer to appended references.

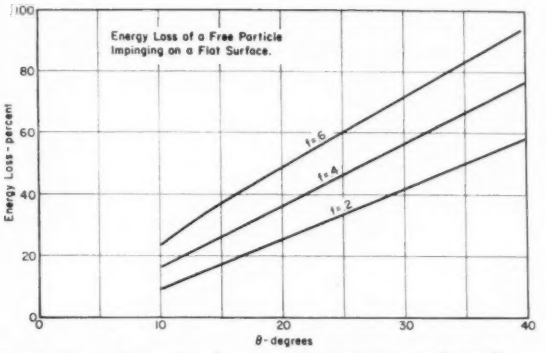

Fig. 2 Energy loss of a free particle impinging inelastically on an inclined flat surface

the inelastic collision will be $\frac{1}{2}\ m\ V_o^2 \sin^2\theta$, as the particle loses all its velocity perpendicular to the plane.

The impact during this loss will also cause a frictional loss resulting in a decrease of particle velocity parallel to the inclined plane. This second energy loss may be evaluted thus:

Conservation of momentum requires that $m\Delta V = \int F\ dt$, where m=mass, ΔV=change in velocity, F=force perpendicular to the plane, dt=the differential of the time interval during impact. In the case of the inelastic collision, ΔV will equal $V_o \sin\theta$; so, for the case of a 1-lb particle,

$$m\Delta V = \frac{1}{g} V_o \sin\theta, \text{ where } g \text{ is the gravitational acceleration.}$$

The force retarding movement parallel to the plane will be

$F \times f$, where f is the coefficient of friction.

The frictional energy loss may be approximated by

$$V_m \times f \times \int F\ dt \quad . \quad . \quad . \quad . \quad . \quad . \quad [3]$$

where V_m is mean velocity parallel to the plane during the impact period.

The friction loss then equals

$$\frac{(V_o \sin\theta) f}{g} \times V_m \quad . \quad . \quad . \quad . \quad . \quad . \quad [4]$$

However, the friction loss may also be approximated as twice the kinetic energy loss between $V_o \cos\theta$ and V_m, or $2\left[(V_o \cos\theta)^2 - V_m^2\right]\left(\frac{1}{2g}\right)$. Equating those representations of the frictional energy loss

$$\frac{fV_o \sin\theta}{g}(V_m) = \frac{V_o^2 \cos^2\theta - V_m^2}{g}, \text{ or}$$

$$V_m^2 + V_m\ V_o f \sin\theta - V_o^2 \cos^2\theta = 0 \quad . \quad . \quad [5]$$

$$V_m = \frac{-V_o f \sin\theta + \sqrt{(V_o f \sin\theta)^2 + 4V_o^2 \cos^2\theta}}{2}$$

$$V_m = \frac{V_o}{2}\left[-f \sin\theta + \sqrt{(f \sin\theta)^2 + 4\cos^2\theta}\right] . \quad [6]$$

The values of the sums of these two energy losses are plotted in Fig. 2.

Because of the mean velocity approximations, the higher loss values are slightly in excess of the true values.

This analysis indicates that particles exiting at the angular extremes given by Kampf can be slowed down very greatly in the first few inches of travel. This difficulty might be easily detected by a polishing of the boot or pipe.

Experiments

Another category into which the frictional energy losses in an impeller blower may be proportioned, is that due to material which is carried around the periphery after failing to exit at the outlet. A group of experiments has been conducted to investigate the influence of certain factors on the amount of material which does recirculate and the manner in which particles do exit from the outlet.

The preceding analyses ignored the influence of air movement in the blower on forage-particle movement.

Some limited tests were conducted to illustrate the directions of air movement in the area of the blower outlet. The inlet area of a commercial blower was blocked except for a ¾x16-in. opening at the top in order to simulate conditions obtained during heavy feeding. The blower (3-ft in diameter) was operated at 800 rpm, and a string attached to a wire rod was passed over the outlet area.

The results (Figs. 3 and 4) show the air moving downward at the outside rear corner and upward at the inside front corner, with severe turbulence in between. Trials made in the pipe, 3 ft above the outlet, showed all air moving upward.

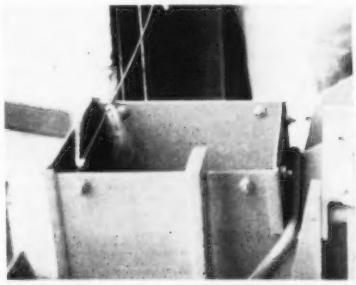

Fig. 3 The positions of the strings illustrate downward as well as upward air movements at blower outlet

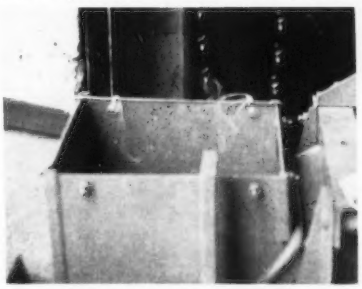

Fig. 4 Downward air movement at the rear of the blower outlet

These results are similar to those found by Barrington *et al* (1), in which particles were noticed moving down the boot.

Raney and Liljedahl (9) offered no explanation for the improved blower performance with rearward-slanted paddles. For additional information on this matter, the rearward-slanted blades were borrowed from Liljedahl (Purdue University), and fitted to a commercial blower of the same model (Fig. 5).

. . . Energy Losses in Blowers

The inlet to this blower was partially blocked in simulation of closure by heavy feeding of forage. The blower normally has an inlet 7 in. high and 16 in. wide. The heights used were 2½ and ¾ in.

The inside of the housing from the cutoff to 8 in. beyond the cutoff was coated with a mixture of grease and paint.

The outlet (2 in. above the cutoff) was covered with a coarse wire mesh.

Pieces of cardboard of ⅛ x 1/32 x 3½ in. weighing 0.2 gm and with $f=0.46$ against galvanized iron, were introduced individually into the inlet through nine symmetrically located holes in the blocked area of the inlet.

The position of each piece of cardboard was recorded as it came to rest on the wire; also recorded were any paint smears, an indication that the piece had been carried completely around the housing.

Trials were conducted for all possible combinations of the two degrees of inlet blockage, for two speeds (600 and 900 rpm), and for the original forward-curved blades and the backward-slanted blades. Tests were also made at the four combinations with the original blades, using 3-in. pieces of 3/16-in-diameter rubber tubing weighing 1 gm and with $f=0.405$ against galvanized iron.

Paint smear observations are shown in Table 1, where each figure represents an average for 54 particles.

TABLE 1. PERCENT OF PARTICLES MAKING ONE FULL ROTATION

Blade	Forward		Forward		Rearward	
Material	Rubber		Paper		Paper	
Opening height	2½	¾	2½	¾	2½	¾
600 rpm	81	68	76	67	37	46
900 rpm	55	67	46	48	31	24

Table 1 indicates that the amount of material making one full rotation in contact with the housing was reduced by *(a)* increasing the rotational speed and *(b)* using rearward-slanted blades.

Measurement of particle position in the outlet clearly indicated that the distribution of particle position is random and independent of inlet opening, rotational speed, blade type, and position of introduction into the inlet area. In no case was it possible to reproduce at will any particle position at exit.

The mean particle position in the 9-by-9-in. outlet was about 3 in. from the outside wall and 3½ in. to the rear of the inlet side.

Observations by Barrington *et al* indicated a movement of particles directly from the inlet toward the outlet as the result of the airstream. This perhaps was a contributing cause for the rather high proportion of particles contacting the painted area of the blower housing near the cutoff.

If it is assumed that the particles in the paint-smear tests made no more than one recirculation, and that all the particles made an average of one-half revolution before reaching the blower exit, then these percentages, when applied with suitable friction coefficients, as done by Blevins (2), tend to account for all the energy requirements not previously segregated, and allow close estimation of the power requirements measured by Raney and Liljedahl, as well as prediction of the variations of these requirements as rotational speed and blade type were varied.

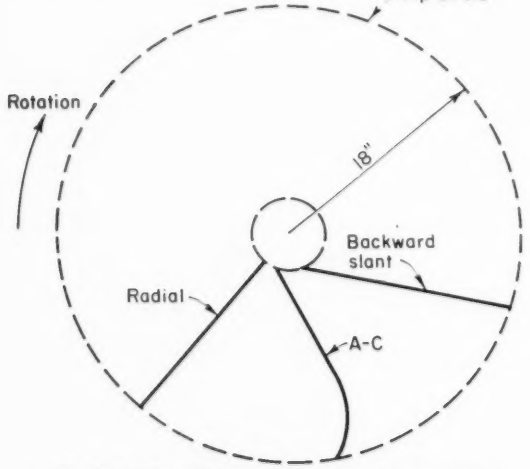

Fig. 5 Impeller blade shapes used in the experiment

Conclusions

Certain definite forms of energy loss are associated with the method by which an impeller blower accelerates solid particles. These losses are greater than the kinetic energy of the escaping particles, and, therefore, efficiency of present designs could never be greater than 50 percent.

The impeller blower fails to function as designed, in that more than half of the material may not be released at the exit and continues to recirculate within the housing. Frictional losses during this recirculation constitute the largest single energy loss. The amount of material recirculated can be reduced by changes in design and in operating conditions.

The magnitude of this recirculation, as well as the observed movements down the boot, indicate that much is yet to be gained through improvement of particle movement in the impeller blower.

References

1 Barrington, G. P., Berge, O. I., Duffee, F. W. and Finner, M. F. Project 406 — Hay harvesting machinery — Blowers, Agricultural Engineering Department, University of Wisconsin, Madison, 1955.

2 Blevins, Frederick Z. Some component power requirements of field-type forage harvesters, Unpublished thesis, Purdue University, 1954.

3 Callum, Charles L. Material flow through the crop blower, Unpublished thesis, University of Wisconsin, 1951.

4 Duffee, F. W. Ensilage cutters, *CREA Handbook*, Committee on the Relation of Electricity to Agriculture, Chicago, Ill., March 5, 1930.

5 Finner, M. F. The aerodynamic characteristics of a forage blower, Thesis, University of Wisconsin, 1958.

6 Kampf, G. Beitrag zur Theorie des Wurfgeblases, *Landtechnische Forschung*, Heft 5, 1956.

7 McLeod, H. E. and Barnes, K. K. Effect of paddle tip clearance on forage blower performance, AGRICULTURAL ENGINEERING, August 1958.

8 Smith, H. K. A preliminary study of the performance characteristics of four commercial blowers, Unpublished thesis, Purdue University, 1956.

9 Raney, J. P. and Liljedahl, J. B. Impeller blade shape affects forage blower performance, AGRICULTURAL ENGINEERING, October 1957.

10 Raney, Russell R. The free throw theory of thrower discharge, Unpublished paper, International Harvester Co., 1946.

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The author is grateful to C. W. Terry, Cornell University, and J. B. Liljedahl, Purdue University, for assistance and cooperation in this study, and to the Allis-Chalmers Manufacturing Company for supplying the equipment used.

. . . Mechanizing Beef Production

(Continued from page 91)

Where multiple-lot feeding units are used, self-unloading wagons with fenceline bunks appear to be the most satisfactory system of feed handling developed to date. One man with a truck-mounted, self-unloading wagon and complete mechanization of feed handling into the wagon can satisfactorily feed 2,000 or more head per day. North Dakota feeders feeding a high roughage ration of 20 to 30 lb of silage per head per day using mechanical silage and concentrate loading equipment are feeding 200 or more per hour per man. Complete blending of the feed ration is accomplished by layering the feed in the unloading wagon. The wagon unloading equipment then mixes the feed as it is unloaded.

The sources of feed supply and the traffic pattern through the feedlots for the feeding equipment must be considered when the layout is made. Excessively long hauls, difficult corners and unnecessary lengths of alleys contribute to extra construction and operating costs. The most economical installation is usually a series of drives from a central feed supply and livestock handling center.

Drainage of Feedlots

Drainage, particularly in northern areas, is a major problem and should be confined as much as possible to surface drainage. Subsurface drainage systems are expensive to install, difficult to keep clear and in northern areas may be frozen during the spring months when drainage is most necessary. Selection of sites that provide good natural drainage, plus the addition of carefully designed central drainage systems, offer some of the opportunities to meet drainage requirements.

Except in arid areas, design and grading of the layout to permit the eventual complete concreting of all lots must be considered by the designer. Because of the quantity of permanently installed equipment, such as fences, feed bunks, drives, waterers, etc., that must be installed, grading that may be required for eventual concreting should be established before construction begins.

In areas where natural drainage is not available and where lots are not hard-surfaced, many operators have bypassed part of the drainage problem by building the lots large enough to permit the establishment of dirt mounds 2 to 4 ft high with an area of about 20 to 30 sq ft per animal in the center of the lot. This mound remains dry and firm during all but the worst weather conditions. Temporary mounds of this same type are frequently made by bulldozing manure into piles in the lot.

Watering Equipment for Feedlots

A beef animal on full dry feed will require a maximum of 10 to 15 gal of water per day. Providing this daily water requirement in 8 hr of pumping time would require a well and pumping system with a capacity of up to 1½ to 2 gal per hour per animal unit. Multiple wells frequently are required for large herds. Automatic heated waterers have become standard items in feeding operations in northern areas. Joint use of a single waterer between two or more lots has been encouraged in smaller lots. An individual waterer for each lot is recommended with larger operations, primarily as a means of reducing the spread of communicable diseases through the common use of water.

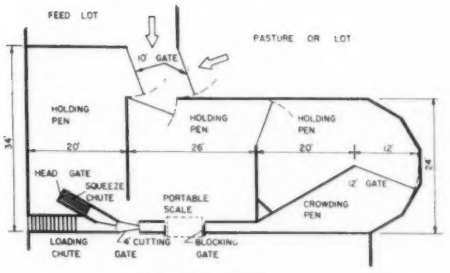

Fig. 4 Multiple-pen corral suitable for general feedlot use

Handling Equipment for Feedlots

Feeders in a lot must be handled periodically. The common practice in checking weights and rate of gain is to weigh by lots or groups of cattle. There is an increased interest in checking rates of gain of individual animals as a means of eliminating the slow or non-gainer. This weighing is normally done at 60 and 90-day intervals after the start of the feeding operation. One North Dakota operator on a single lot of 259 head fed a uniform ration had a rate of gain on a 60-day feed period ranging from +0.37 lb per animal per day to a +2.7 lb per animal per day. This particular lot was sorted at the 1.7 lb per day gain level. An analysis of the gain record for the herd showed that, at the same per day per animal feed costs the animals above the 1.7 lb gain per head per day had an average daily gain of 0.3 lb per day greater than those animals below the 1.7-lb figure. This type of production control is becoming more common, particularly when light calves are being fed. Handling facilities must be provided to permit frequent and easy weighing.

A common set of pens, chutes, scales and headgates easily accessible to the central alleys provides an excellent facility for receiving and loading, weighing, spraying, veterinary services or any other activity that may be required. Quarantine and hospital facilities removed from, but accessible to, these facilities would complete the unit.

Some basic considerations in the design of these handling facilities are as follows: Provide adequate pens for division of lots into at least three groups. Install a system with one pen large enough to hold a full lot of cattle, usually about 200 head as a maximum. Provide smaller working pens no more than about 20 to 30 by 20 to 30 ft in size. Larger pens cause difficulty in handling the cattle. The wedge-shaped chute or a chute with adjustable widths is frequently preferred to the rectangular chute because of the many sizes of cattle that must be handled. (Fig. 4 shows a typical handling facility used by many feeders.)

In the past, many livestock operations have grown with no predesigned plan. Engineers are playing an increasingly greater role in providing a comprehensive plan for the orderly development of livestock operations both large and small. Because of the limited amount of research and data available on the layout and design of these systems, most of the layout work must be done on the basis of experience. There is need for concentrated research in the design and operation of these meat production factories by a combination of engineers, animal husbandrymen and economists, particularly with respect to time-and-motion studies and capital investments.

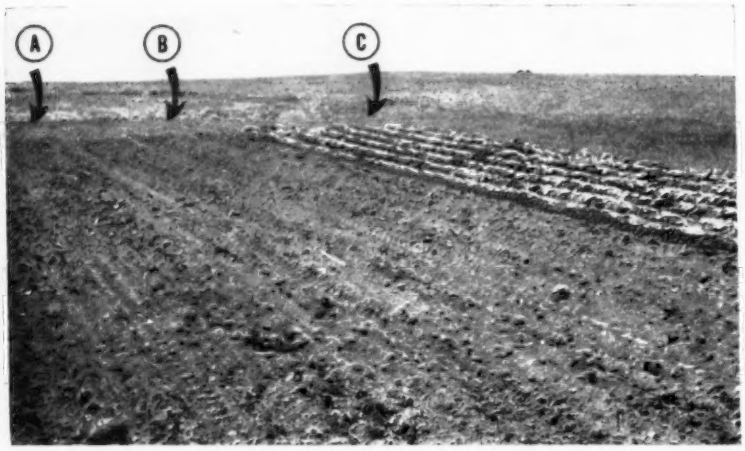

Fig. 1 General view of one replicate just after planting corn. Seedbeds, left to right, are (A) stubble mulch, (B) conventional, and (C) plow-plant

Minimum Tillage for Soil and Water Conservation

George R. Free
Member ASAE

Least manipulation of soil for satisfactory planting, germination, growth and yield of crop

TILLAGE for soil and water conservation is by no means a new concept. Many agricultural engineers, as well as soil and crop scientists and farmers, are already familiar with such practices as contouring, crop-residue tillage, subsoiling, and many others.

For any new tillage practice or combination of practices, benefits should balance or exceed costs if there is to be widespread acceptance and use. When, as in the case of minimum tillage, there appears to be the possibility of reducing costs and also gaining benefits from the standpoint of soil and water conservation, the concept is particularly attractive.

The concept of minimum tillage for corn appears to have originated in Ohio and then spread to Michigan and other areas where corn is an important crop. Minimum tillage may be defined as the least possible manipulation of the soil for satisfactory planting, germination, stands, growth, and yields of a crop. The usual approach has been to endeavor to eliminate or to reduce the severity of some of the operations and traffic associated with conventional seedbed preparation which usually includes plowing, followed by harrowing or disking and soil packing.

Minimum tillage which leaves as much of the soil as possible coarse, rough, and uncompacted should have definite advantages from the standpoint of control of runoff and erosion. From this standpoint, also, protection of the soil by surface litter might be desirable.

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More information is needed on the place and limitations of the various kinds of minimum tillage. It should be emphasized, however, that minimum tillage will not make good soil structure, but will merely help preserve it for useful purposes if present in the untilled soil.

The object of this paper is to discuss the practice of minimum tillage for soil and water conservation from the following standpoints: *(a)* reasons for the current interest in the practice, *(b)* some requirements that should be considered, and *(c)* the present status of development of the practice in New York state.

Reasons for Interest

Man made a great step forward in tillage when animal power replaced the sharpened stick used as a hand tool. In modern times, and within the experience of many of us, farming has gradually become more and more mechanized. With this change, the number of acres that can be farmed by one individual has increased tremendously. At the same time, the tiller of the soil has less time to think in poetic terms of furrows of upturned soil and the phenomena of plant growth. Farming is now a business, rather than a way of life, and efficient management is the key to staying in business as never before. Methods that are wasteful of time or other resources cannot be tolerated.

In addition to mechanization, with its benefits of plenty of power and ability to time and speed up operations properly, there are other modern developments that relate to the question of tillage. One of the most important of these is the control of weeds by means other than tillage. Mulches, flame, oil sprays, and herbicide chemicals have been most effective. Their relationship to tillage needs little discussion here.

Modern fungicides and other soil and seed treatments have also influenced tillage to some extent. For example,

seedbed preparation and planting may be earlier because of increased protection against decay and maggot damage.

Another change lies in the fact that the fertility and tilth of virgin soils can no longer be exploited. It is not to be inferred here that all virgin soils were fertile, but in many cases tillage has been used to wring out too much of the inherent fertility and tilth without enough attention to replacement.

Today more and more of the plant nutrients to maintain or increase yields are being supplied in the form of commercial fertilizer. It has also been found that synthetic soil conditioners can stabilize soil physical conditions to order in many soils. They can be used to improve structure and tilth. Because of costs, however, this practice is confined at present to special situations.

Limiting factors assume greater importance at the high yield levels of today. As an example of modern yields, more and more farmers have broken the 100-bushel per acre corn-yield barrier, and are now trying for 200, or even 300. Inadequate physical condition resulting, at least in part, from improper tillage practices, may well be one of the obstacles to further progress.

Undesirable man-made compaction of agricultural soils seems to be increasing. There is not complete agreement yet as to whether the fault lies in excessive use or misuse of the machine, or whether in some situations the upper limits of the capacity of soils to "take it" are being reached under intensive systems of management. At any rate, the problem appears to be most acute where there is intensive cropping, lots of traffic and tillage, and relatively low quantities of organic matter are being returned to the soil.

It may not be easy to define, achieve, and maintain optimum physical conditions for crop production. From the standpoint of soil and water conservation, however, it is known that dry, pulverized soils can be eroded by wind, and that overworked or compacted soils, particularly those with a low degree of water stability, are subject to water erosion and drainage problems.

Notable advances in the application of soil and water conservation measures on the land have been made. Despite this, there are still many situations where standard recommendations such as contouring are not widely accepted and followed, and the control of runoff and erosion is inadequate. Possibly some of the newer tillage practices can be utilized to permit appreciable deviations from contour tillage with no serious soil and water losses. There are other situations where tillage practices may be helpful, but it is important that seedbed requirements be recognized.

It has been said that the tillage of soil is an art rather than a science. If this means that detailed specifications for the preparation of optimum seedbeds for all crops, soils, seasons, and systems of management cannot be given, it is undoubtedly true and will remain true for some time to come. There are many situations, however, where the odds for success might be improved by consideration of some of the seedbed requirements.

Crop Requirements

When the seedbed is being prepared for seeds to be germinated and grown in place, as contrasted with set plants, the kind of seedbed needed will obviously be determined to some extent by the seed size. Small seeds can be buried too deep in a cloddy seedbed, or, at the other extreme, not be covered at all. Conversely, larger seeds such as corn can tolerate a relatively coarse seedbed. Differences in requirements with respect to seed size are generally recognized. The maximum depth from which emergence will occur appears to be sufficiently critical as to be affected by seed size variation within a given crop(2)*.

Equipment used for placing the seed or plant must be considered. The soil for row planting, at least in the row area, cannot be too rough or cloddy, nor contain too much coarse litter on the surface or within the planting depth. More and more emphasis is being placed on precision planting of row crops to insure desired stands and spacing.

With the seed placed at the proper depth in the seedbed, environmental conditions in the soil must be satisfactory and remain so for seed germination, plant emergence, and growth. Soil conditions are important for growth of set plants also, even though germination and emergence are not involved.

It is probably easier to consider the seedbed in terms of the size and compaction status of the solid phase—the soil separates—rather than in terms of porosity and the gaseous and liquid phases. In doing this, however, it must be kept in mind that many kinds of structures can be built from the same structural units. The classic example of this is the randomly oriented and loosely fitted pile of brick, and the closely fitted wall possible with systematic placement.

Yoder (18) studying seedbeds for cotton comprised of various starting combinations of soil separates from less than 1/16 in. to greater than 4 in. in size, reported satisfactory emergence and best growth with separates 1/8 to 1/4 in. in size. Results with the 1/4 to 1/2-in. size were nearly the same. By the end of the growing season, about 72 to 74 percent of the soil in these two seedbeds remained in the starting size class. Non-capillary porosity changed from 42 percent of the gross soil volume to 32 percent. Yields resulting from the use of separates less than 1/16 in. were less than half of maximum.

Hagin (8) reported sizes below 0.5 mm less satisfactory for tomatoes than coarser material, as did Rai *et al* (15), working with a soil 30 percent water stable. Rai and his associates, however, reported best results with the finer separates when they were 45 percent water stable. Zwerman *et al* (19), working with seedbeds comprised of 1/8 to 1/4-in. structural units, reported stability of little importance except under extremely high moisture levels. These findings emphasize the importance of separate size and the important role that weather conditions and the stability of separates may play as the season progresses.

The structural status of a seedbed over the season is seldom homogeneous in any direction. For example, depending upon rainfall, soil exposure, and the size and stability of initial separates, there is often some degree of crusting at the surface. Domby and Kohnke (5) recently reported that the effect of a crust in reducing soil aeration is marked at low moisture tensions. Except in the very wet range, however, small variations in moisture had more effect on diffusion rates than did the crust.

Some degree of compactness below the surface may be desirable, in order that seedlings have a floor to push

*Numbers in parentheses refer to the appended references.

against. This concept of a firm footing to assist cotton plants to break through thin crusts was advanced by Carnes in 1934 (3). Other benefits of moderate compaction are an increased capacity for storage of available moisture, a more rapid movement of moisture by capillarity, and better transfer of moisture from the soil to the seed. A recent review by Jamison (9) may be of interest here.

The relationship of excessive compaction to plant growth is not so well defined as its relation to drainage, erosion, and runoff. It is recognized, nevertheless, that there may be effects on root growth through physical impedence, reduced aeration, or buildup of toxic materials. Excessive manmade compaction may, depending upon its location in the profile, be of a temporary nature; *i.e.*, such that it is removed when plowing, or it may at such a depth that it tends to accumulate. There are also many soils which are inherently and naturally more compact than desired.

Adequate aeration may be a problem in any part of the seedbed or root zone. Lemon and Erickson (10) working with different seedbeds comprised of well-aggregated soil units both more and less than 0.8 mm in size, reported low rates of oxygen diffusion in both gaseous and liquid phases in the fine material. A water table was maintained under all these seedbeds at a depth of 40 cm. The green weight of tomato plants growing in soil below 0.8 mm in size was only about one-third the weights of plants grown in coarser soil where aeration was markedly better.

There is an increasing amount of quantitative data becoming available on the relationships between aeration, soil moisture tension, and growth. Gingrich and Russell (7) have reported marked effects on 24-hr growth of corn roots and seedlings at 25 C under various combinations of soil moisture tension and percentage of oxygen in the aerating gas. At low moisture tensions, changing the oxygen percentage from 2.1 to 10.5 percent increased the rate of root elongation nearly threefold.

In view of the complex variability in structure, aeration, moisture and temperature that must exist in the soil under normal field conditions, the maintenance of physical conditions for optimum growth in the field would seem to be a goal attainable only by chance. There should, however, be recognition in tillage and soil management of the interrelationships and the critical values for each factor.

In order to help provide adequate aeration through control of excess moisture, ridging of soil before planting may be an essential part of the tillage necessary for preparation of seedbeds.

Another requirement not previously mentioned pertains to temperature. Size of structural units and state of compaction and moisture can be changed by tillage to influence soil temperatures. Seedbed roughness with its effects on air turbulence is a factor which has received little consideration to date from the standpoint of soil temperature and moisture.

Weed Control Requirements

Two main requirements should be mentioned here. One is the destruction or control of vegetation existing on the area prior to seedbed preparation, and the other is the control of weeds after the crop has been planted.

Chemicals have been successfully substituted for tillage in preparing seedbeds for pasture renovation or seeding (16) and also for tillage for corn (4). This practice may be feasible for certain soils and crops. Claims of corn yields of from 70 to 100 bushels per acre *without any tillage* — except for a narrow slit to get the seed in and covered (4) — cannot be disregarded if one is considering minimum tillage.

Weed control by herbicides is being widely used as a complete or partial substitute for cultivation. Generally, crusting is such that all cultivation cannot be eliminated without some sacrifice of yields.

Soil and Water Conservation Requirements

The size of clods and aggregates, their stability, and state of compaction affect infiltration, permeability, susceptibility to movement by wind and water, and moisture relations.

Rai *et al* (15) reported data showing that between size limits of 4 mm and 0.5 mm a decrease in size by one-half increased erosion by a factor of 2. Below 0.5 mm, the factor was about 5.

Wilson and Browning (17) reported that the amount of erosion on Marshall silt loam was inversely related to the percentage of aggregates greater than 2 mm.

Traffic on agricultural soils has been found to have a marked effect on infiltration rate and permeability (6). A summary of soil investigations in the surface three inches of prepared seedbeds in several experiments in New York showed that compaction by tractor wheels in middles where traffic was concentrated had increased bulk densities by 9 to 23 percent. Porosity at 60 cm water tension was decreased 28 to 42 percent and permeability was decreased by 60 to 93 percent.

Development of Minimum Tillage in New York

Tillage experiments were started in New York on two different soils in 1946-47†. The four-year rotation followed consisted of corn, oats, wheat, and clover hay.

Results of these experiments, terminated in 1950, can be summarized as follows:

1 On both well-drained Honeoye silt loam and the less well-drained Mardin silt loam, preparation of at least some of the seedbeds for crops of the rotation by plowing gave higher yields than preparing all with a disk or field cultivator.

2 On the Honeoye soil, the number of secondary seedbed operations (harrowings) had no significant effect on yields of any crop of the rotation. On the Mardin soil, yields of corn were reduced about 6 bu per acre by three fitting operations. This reduction was significant at the 5 percent level.

Cultivation was held constant in these experiments, and no herbicides were used. Much of the prevailing secondary seedbed preparation appeared to be not only wasteful of time and power but actually harmful from the standpoint of corn yields on the Mardin soil.

In 1951, R. B. Musgrave started the development of a practical system of eliminating the usual fitting operations following plowing and combining the operations of plowing and planting without greatly altering the basic equip-

†Tillage experiment on Mardin silt loam near Ithaca, N. Y., by M. B. Russell and R. B. Musgrave (unpublished report); tillage experiment on Honeoye silt loam at Marcellus, N. Y., by M. B. Russell and G. R. Free (unpublished report).

ment and features of either operation (11, 12). His estimate of $10 to $15 per acre saving may be too high for some situations, but an appreciable reduction in cost of production is obvious. Plow-plant is considered especially desirable where soil moisture is suitable for plowing and planting, but too high for the conventional secondary seedbed preparations and traffic. Corn yields were reported to be about the same as those with conventional practice. Others (13, 14) have described once-over operations and equipment, but their objectives were different, or included an attached packer or mulcher.

Comparisons of plow-plant and conventional methods have been made by the agronomy and agricultural engineering departments of the Cornell University college of agriculture on several private farms in New York. Some farmers are capitalizing on the idea of minimum tillage by eliminating unnecessary fitting operations, even though they do not plow-plant.

Another tillage study on Honeoye silt loam was started in 1952 to determine the effect of varying the number of fitting operations, cultivations, and traffic passes on corn yields under continuous culture. Data previously cited were for corn in a four-year rotation. To date, there has been no evidence of any marked cumulative effects of treatments on corn yields. Mean yields for a seven-year period of 81.0, 80.5, and 78.4 bushels per acre, respectively, for 0, 3, and 9 fitting operations are typical of the results obtained. It would be hazardous, however, to predict from seven years' results that intensive tillage and traffic in this experiment will not in time significantly reduce yields. Probably few areas where soil compaction is now a serious problem reached that state in a few years' time.

Weed counts made in the fall of the first year of this study showed that with minimum cultivation following planting, the weed population was the lowest with minimum fitting after plowing. This checks the observations of Musgrave and his associates (11), that fitting of the interrow area merely conditions the soil for better growth of weeds.

There was a progressive decrease in weed population, particularly of grasses, as the number of cultivations increased. However, one postemergence spray, a uniform treatment for all plots of the experiment, and two cultivations have provided adequate control of weeds. Some years there have been small increases in yields from additional cultivation.

The soil and water conservation aspects of minimum tillage are of particular interest. In cooperation with the agronomy and agricultural engineering departments at Cornell, two additional tillage experiments were started at Marcellus in 1956. In one, plow-plant and also stubble-mulch seedbeds are being compared with the conventional on plots where runoff and erosion can be measured. The crop is corn, fertilized with 10-10-10 at 1,000 lb per acre. The runoff and erosion control afforded by all three methods of seedbed preparation was excellent during the one and only test storm which occurred during the 1956 growing season. Only two test storms occurred in 1957, and these again failed to clearly differentiate treatments. The storms in both 1956 and 1957 occurred late in the growing season.

In 1958 there were five small records of runoff during the growing season, but with a total soil loss from conventional treatment of only 1.5 tons per acre, lower losses from both stubble-mulch and plow-plant treatments can be considered gratifying, but hardly conclusive. Certainly a choice between the two conservation tillage systems, stubble-mulch and plow-plant, cannot be made from the standpoint of erosion control on the basis of data obtained to date. What is needed is either more large test storms at critical periods, or tests under simulated rainfall where evaluation would be less dependent on weather.

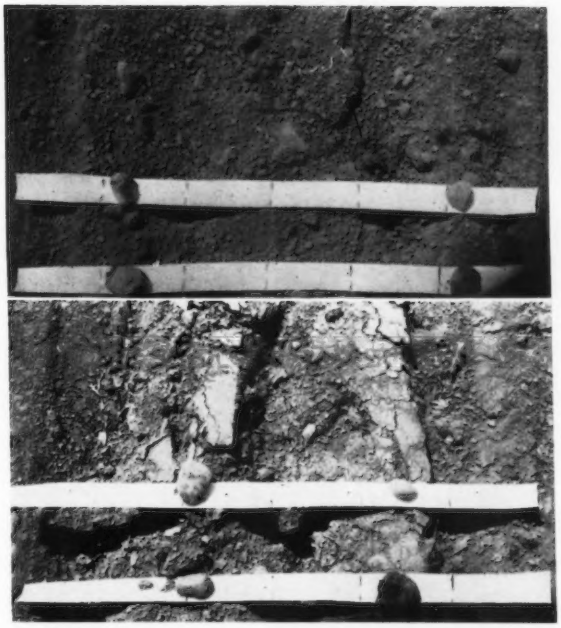

Fig. 2 Close-ups of two of the seedbeds shown in Fig. 1. Upper, conventional seedbed; lower, plow-plant. (The white markers extend between 36-in. corn rows)

The type of seedbed produced by these three tillage treatments in another experiment is shown in Fig. 1. Close-up views of conventional and plow-plant seedbeds are shown in Fig. 2.

Maximum soil temperature, measured in corn rows after planting and at depths of 2 or 4 in., have been from 1 to 2 F higher under plow-plant than under conventional. Horizontal variations of soil temperatures across rows and middles under plow-plant is slight just after planting compared to differences of 6 or 7 deg under conventional with the lowest temperature occurring in wheel tracks.

The logical explanations for these temperature differences lie in porosity, moisture, and roughness relationships as influenced by fitting and compaction. To what extent they are a function of moisture, or possibly a determinant of moisture, is still under study. Soil temperatures are being followed more closely in current studies, since differences of this magnitude can conceivably affect plant and root growth.

Conclusions

Minimum tillage for large seeded field crops, such as corn, is feasible and practical under New York conditions. Advantages from the standpoint of gains in efficiency and cost of production are obvious.

The concept of minimum tillage can be carried so far as to include plowing and planting in one operation. This

(Continued on page 103)

Energy of Falling Drops
from Medium-Pressure Irrigation Sprinkler

A method of determining total energy and the effect of combinations of nozzle size and pressure on the energy received

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THE energy of falling drops of water from either rainfall or irrigation sprinklers must be converted to other forms of energy such as heat or must do work. Work may be done in overcoming the surface tension of the drops when the parent drop is shattered and smaller ones formed; soil aggregates may be torn apart (11, 12)*; soil particles may be moved horizontally and vertically (4, 5, 7, 8, 9, 13); shattered drops may be imparted with a horizontal and vertical velocity (1), and turbulence may be introduced into surface runoff waters (7). The task of research is similar to that expressed for natural rainfall (6). First, the total energy of the falling drops must be measured; and, second, the amount of total energy used in deleterious effects on the soil must be determined. This paper reports a method for determining the total energy of falling drops and the effect of four combinations of sprinkler-nozzle size and pressure on the energy received on a target placed at ground level.

Applicability of Stress-Analysis Techniques

The energy of moving water drops has been determined in several ways (10, 14). A device called a transducer (15) was constructed whereby the physical displacement of an elastic member is changed into an electrical signal by the use of strain gages. Proper instrumentation is needed to pick up and magnify such a signal for recording and study.

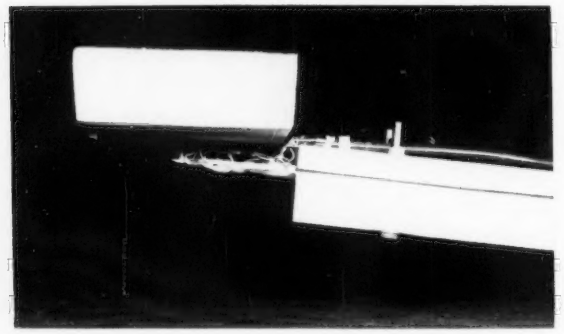

Fig. 1 The cantilever beam was a steel strap 1⅞ x 3/64 in., and had an overhang of 4 in. The styrofoam target, 16.5 by 30.3 cm, was mounted on a stove bolt secured to the end of the cantilever beam. Two strain gages (SR4 Type A-12) were fastened to the top of the beam and two on the underside of the beam. Gages and electrical connections were carefully waterproofed

Paper presented at the Winter Meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 1957, on a program arranged by the Soil and Water Division. Based on a doctoral thesis prepared by the senior author while attending Michigan State University. Authorized for publication as Journal Paper 2434 of the Michigan Agricultural Experiment Station.

The authors — PAUL E. SCHLEUSENER and E. H. KIDDER — are, respectively, associate professor of agricultural engineering, University of Nebraska (Lincoln), and associate professor of agricultural engineering, Michigan State University (East Lansing).

*Numbers in parentheses refer to appended references.

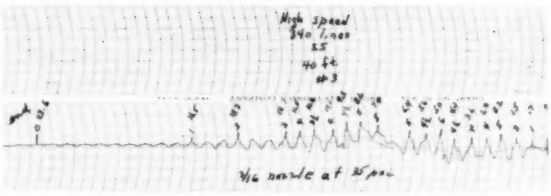

Fig. 2 Oscillograph trace of energy received

The transducer used for this study utilized a steel cantilever beam for the elastic member. A target of styrofoam† was attached to the free end of the cantilever beam. The energy imparted by the water drops striking the target area caused the beam to deflect resulting in a strain in the elastic member. Since maximum strain occurs at the fixed point of a cantilever beam, strain gages were attached near that point. The transducer constructed for measuring the energy imparted by the falling drops is shown in Fig. 1.

Energy of Drops Striking Target

The record made by the oscillograph, when the target was subjected to the falling drops, consisted of a series of oscillations across a shifting base line (Fig. 2). The base line changed as the total inertia load of the target and beam changed. Changes in the inertia of the system occurred as water was added from the falling drops and as excess water drops fell off the system. The oscillograph record was divided into intervals of time convenient for analyzing the energy change of the system (16). The energy change per unit of time was plotted against time and the total energy was determined by measuring the area under the resulting curve (Fig. 3).

The illustrated curve is typical of the data. When the first few drops from the sprinkler reached the target small energy changes occurred. Then one or more peak energy changes occurred while the bulk of the water struck the target area. Finally, the energy change damped off as the last few drops reached the target.

The total energy received at the target varied exponentially with the distance from the nozzle (Figs. 4, 5, and 6). As the distance from the nozzle increased the amount of total energy received increased very rapidly.

The energy at points within 25 feet of the nozzle could not be obtained with the transducer used in this experiment.

†Styrofoam has low density, thereby keeping the inertia of the system to a minimum. It is also resistant to water penetration.

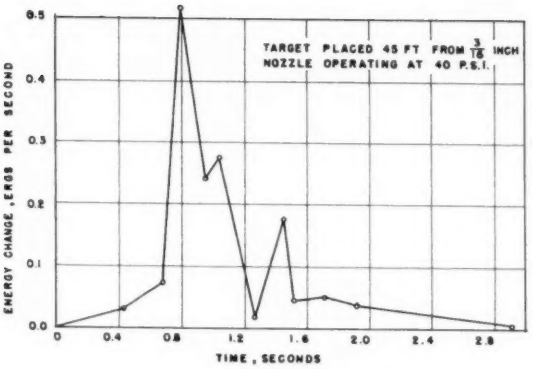

Fig. 3 Rate of change of energy

The transducer was not sensitive enough to permit analysis of the oscillograph records for those points.

The 5/32-in. nozzle operating at a pressure of 30 lb per sq in. produced drops that imparted the largest amounts of energy received by the target (Fig. 4). When the target was located at points farther than 25 ft from the sprinkler a reduction in energy was obtained by increasing the pressure to 35 lb per sq in.

A further reduction in energy occurred at a pressure of 35 lb per sq in. by increasing the nozzle size from 5/32 to 3/16-in. diameter (Fig. 5). Such energy reductions became negligible at 40 feet from the sprinkler. At points greater than 30 feet from the sprinkler greater energy reductions were obtained by increasing the nozzle size to 3/16-in. and by increasing the pressure to 40 lb per sq in. (Fig. 6).

Consequently the least destructive action to the soil would occur by the use of a 3/16-in. diameter nozzle operating at 40 lb per sq. in. The use of the other three combinations of nozzle size and pressure resulted in greater energy imparted to the target.

Energy was delivered to the target during less than four percent of the total time (Fig. 7). During the short time

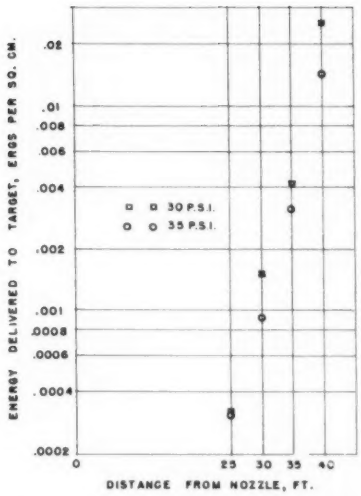

Fig. 4 Effect of nozzle pressure on energy of drops for 5/32-in. diameter nozzle

interval that drops struck the target, the delivery of energy to the target was not uniform. The non-uniformity of energy delivery is indicated by the changing slope of the lines. A flat slope of the lines during some time intervals indicates that little or no energy was imparted to the target. When the line has a greater slope, a rapid delivery of energy is indicated. The maximum rate of delivery of energy observed in this investigation was at the rate of 47 ergs per second. This maximum value was measured 40 ft from the 5/32-in. nozzle operating at 30 lb per sq in. pressure.

Water-Application Rates

Apparent water-application rates have been determined for sprinklers by using catchment cans and by averaging the total fall of water over the total period of time the

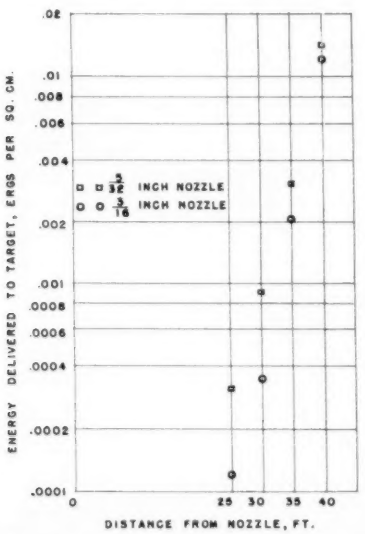

Fig. 5 Effect of nozzle size on energy of drops, 35 psi

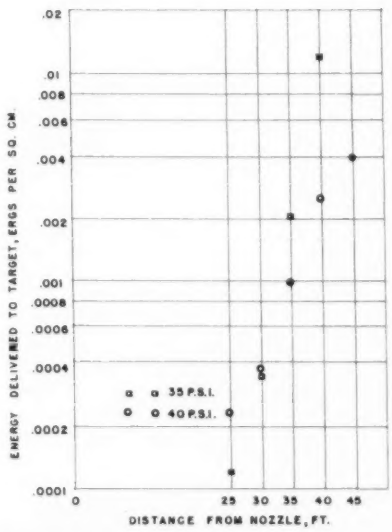

Fig. 6 Effect of nozzle pressure on energy of drops, 3/16-in. diameter nozzle

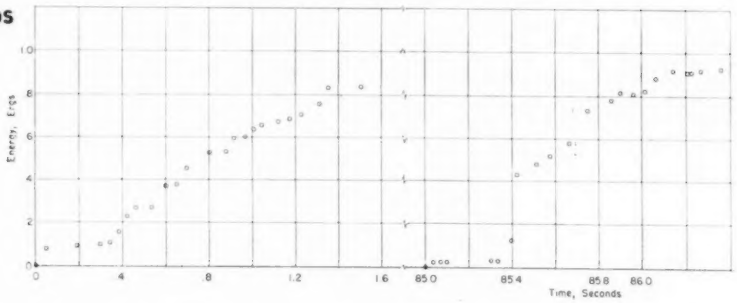

Fig. 7 Massed energy curve, 35 ft from 5/16-in. nozzle operating at 35 psi

sprinkler was operated (2, 3, 17). Similar calculations were used to obtain the data in columns three and five in Table 1.

TABLE 1. WATER APPLICATION RATES (Inches per hour)

Distance from nozzle, ft	Averaged over application time (true)	Averaged over total time (apparent)	Averaged over application time (true)	Averaged over total time (apparent)
	(5/32-inch diameter nozzle)			
	30 psi		35 psi	
25	0.5	0.01	1.9	0.04
30	1.9	0.05	2.4	0.05
35	4.0	0.06	2.2	0.05
40	5.4	0.11	4.6	0.07
	(3/16-inch diameter nozzle)			
	35 psi		40 psi	
25	2.1	0.04	3.4	0.10
30	3.6	0.05	3.5	0.12
35	4.8	0.06	3.7	0.11
40	7.5	0.08	6.8	0.13
45			0.86	0.08
1	2	3	4	5

True application rates in the even-numbered columns of Table 1 were obtained by averaging the total fallout of water over the exact time interval during which it fell on a particular target area. The true application rates were fifty to ninety times greater than the apparent application rates.

Changes in operating pressure and nozzle size caused changes in the true water-application rate. An increase in pressue from 30 to 35 lb per sq in. at the 5/32-in. nozzle caused a reduction in true water-application rates at points beyond 30 ft from the nozzle. At 35 lb per sq in. an increase in nozzle size from 5/32 to 3/16-in. diameter caused an increase in the true water application rates at the points tested. An increase in operating pressure from 35 to 40 lb per sq in. at the 3/16-in. nozzle caused a reduction in true water-application rates at points farther than 25 ft from the sprinkler.

The increment of pressure increase recommended by the manufacturer as the difference between undesirable and desirable operation of sprinklers on bare soils was effective in reducing the highest values of the true water-application rates occurring in the area farther than 30 ft from the nozzle. Such reductions tended to make the application rates more uniform along a radius emanating from the sprinkler.

The calculation of true water-application rates included a possible error of as much as 30 percent. Nevertheless a clearer understanding of the phenomena of water application by rotating sprinklers and their effects upon the soil may be obtained by calculating water-application rates on the basis of actual time of water application.

Conclusions

1 Energy imparted by water drops from a sprinkler striking a target near the ground increased exponentially with increased distance from the nozzle.

2 Energy was delivered to the target during less than four percent of the total time of operation.

3 True water-application rates, based on the actual time of water application, were as high as 7.5 in. per hr ranging from fifty to ninety times as great as the apparent application rates based upon total elapsed time. The increment of pressure increase recommended by the manufacturer as the difference between undesirable and desirable operation of sprinklers on bare soils, was effective in reducing the true water-application rates occuring in the area farther than 30 ft from the nozzle.

Recommendations

1 Detailed studies of the energy imparted by drops from irrigation sprinklers should be continued.

2 True water-application rates should be determined.

3 Energy patterns similar to those reported herein should be applied to typical irrigated soils to measure changes in soil condition caused by that application of energy. Evaluation of the changes caused by the energy application will permit: *(a)* the sprinkler manufacturer to make necessary changes in nozzle design to meet prevailing soil conditions, *(b)* irrigation-systems designers to be better able to select the proper combination of nozzle size and operating pressure to minimize harmful structural changes in the soil, caused by excessive quantities of energy applied to the soil, and *(c)* permit irrigators to use properly designed and selected equipment without severe damage to soil physical characteristics.

References

1 Bennett, H. H., Bell, Forrest G., and Robinson, Bert D. Raindrops and erosion. U.S. Department of Agriculture Circular No. 895, 23 pp., 1951.

2 Bilanski, Walter K., and Kidder, E. H. Factors that affect the distribution of water from a medium-pressure rotary irrigation sprinkler. *Transactions of the ASAE*, 1:19-23, 1958.

3 Christiansen, J. E. Irrigation by sprinkling. University of California Agricultural Experiment Station, Berkeley, Bulletin 670, October 1942. 124 pp.

4 Ekern, Paul C. Raindrop impact as the force initiating soil erosion. Soil Science Society of America Proceedings, 15:7-10, 1951.

5 Ekern, Paul C., and Muckenhirn, R. J. Water drop impact as a force in transporting sand. Soil Science Society of America Proceedings, 12:441-444, 1948.

6 Ellison, W. D. Some effects of rain drops and surface-flow on soil erosion and infiltration. Transactions American Geophysical Union, 26:415, 1945.

7 Ellison, W. D. Soil erosion studies, parts I-VII. AGRICULTURAL ENGINEERING, 28:145, 197, 245, 297, 349, 402, 442, 1947.

8 Free, George R. Soil movement by raindrops. AGRICULTURAL ENGINEERING, 33:491, 1952.

9 Green, Robert L. A photographic technique for measuring the sizes and velocities of water drops from irrigation sprinklers. AGRICULTURAL ENGINEERING, 33:563, 1952.

10 Katz, Isadore. A momentum disdrometer for measuring raindrop size from aircraft. Bulletin American Meteorological Society, 33:365-368, 1952.

11 McCalla, T. M. Influence of biological products on soil structure and infiltration. Soil Science Society of America Proceedings, 7:209-214, 1942.

12 McCalla, T. M. Water-drop method of determining stability of soil structure. Soil Science, 58:117-121, 1944.

13 Mech, S. J., and Free, G. R. Movement of soil during tillage operations, AGRICULTURAL ENGINEERING, 23:379, 1942.

14 Neal, J. H., and Baver, L. D. Measuring the impact of raindrops. Journal of American Society of Agronomy, 29:708, 1937.

15 Perry, C. C., and Lissner, H. R. The strain gage primer. New York: McGraw-Hill Book Company, Inc., 281 pp., 1955.

16 Schleusener, Paul E. Drop size distribution and energy of falling drops from a medium-pressure irrigation sprinkler. Unpublished doctor's dissertation, Michigan State University, East Lansing, 1957.

17 Wiersma, John L. Effect of wind variation on water distribution from rotating sprinklers. South Dakota State College Agricultural Experiment Station, Brookings, Technical Bulletin No. 16, 18 pp., May 1955.

Consulting Agricultural Engineers

MEMBERS of ASAE who are employed as consulting agricultural engineers or wish to be listed as such in the "Consulting Agricultural Engineers" section of the 1960 AGRICULTURAL ENGINEERS YEARBOOK (See pages 392-394, 1959 edition) are urged to supply the necessary information by March 1, 1960.

All that is required to be listed is to furnish: complete name and address, a brief description of consulting services (not to exceed 50 words), specify whether registered professional engineer, and list specialty by division interest; such as, Power and Machinery, Farm Structures, Electric Power and Processing, and Soil and Water. Those whose services extend beyond one division may be listed accordingly. Send the above information to the attention of J. Basselman, Editor, AGRICULTURAL ENGINEERS YEARBOOK, 420 Main St., St. Joseph, Mich.

Agricultural Engineering College Training Survey

A SURVEY of farm machinery industry requirements for the training of agricultural engineers was conducted among the members of the Farm Equipment Institute during the summer of 1959 to help answer the question, "How can the college training for professional agricultural engineers in agricultural colleges be improved to better equip graduates for careers in the farm equipment industry?" The Agricultural Research Committee of FEI suggested this survey as a means for bringing information to the agricultural engineering colleges regarding the potential demand for professional agricultural engineers and to indicate what kind of professional training industry employers believe will result in the best opportunities for graduates of agricultural engineering schools in two major areas of employment — (1) research and design; and (2) product planning and sales and service. In making the study, questionnaires were sent to 138 member companies of FEI. Usable questionnaires were returned by seven full line companies and fourteen short line companies.

A report of the survey was presented by Carl L. Hecker, president of Oliver Corporation, at the Farm Equipment Institute "dinner for professors," held during the Winter Meeting of ASAE. Copies may be obtained by writing to the American Society of Agricultural Engineers, 420 Main St., St. Joseph, Michigan.

. . . Minimum Tillage

(Continued from page 99)

assumes, of course, that conditions are such that a good plowing job is possible.

Minimum tillage is desirable from the standpoint of erosion and runoff control, because of larger aggregate or clod size and decreased compaction. Quantitative data on the magnitude of benefits are needed. Musgrave's plow-plant procedure, since it minimizes traffic and leaves interrow areas open and rough during the early growth period, should be particularly desirable.

References

1 Aldrich, Sam R. New styles in seedbeds. *What's New in Crops and Soils*, 9(2):12-15, 1956.

2 Black, J. N. The influence of seed size and depth of sowing on pre-emergence and early vegetative growth of subterranean clover (*trifolium subterranean* L). Jour. Agr. Res. Australia, 7:98, 1956.

3 Carnes, A. Soil crusts. AGRICULTURAL ENGINEERING 15:167, 1934.

4 Davidson, John H. and Barrons, Keith C. Chemical seedbed preparation—a new approach to soil conservation. Down to Earth, 10(winter), 1954.

5 Domby, C. W. and Kohnke, Helmut. The influence of soil crusts on gaseous diffusion. Soil Sci. Soc. Amer. Proc., 20:1, 1956.

6 Free, G. R. Traffic soles. AGRICULTURAL ENGINEERING 34: 528-531, 1953.

7 Gingrich, J. R. and Russell, M. B. Effect of soil moisture tension and oxygen concentration on the growth of corn roots. Jour. Amer. Soc. Agron, 48:517-520, 1956.

8 Hagin, J. Influence of soil aggregation on plant growth. Soil Sci., 74:471-478, 1952.

9 Jamison, Vernon C. Pertinent factors governing the availability of moisture to plants. Soil Sci., 81:459-471, 1956.

10 Lemon, E. R. and Erickson, A. E. The measurement of oxygen diffusion in the soil with a platinum microelectrode. Soil Sci. Soc. Amer. Proc., 16:160-163, 1952.

11 Musgrave, R. B., Zwerman, P. J. and Aldrich, S. R. Plow-planting of corn. AGRICULTURAL ENGINEERING, 36:593-594, 1955.

12 Musgrave, R. B. Researchers find many advantages in plow-plant method. Farm Research, 22(2):9, 1956.

13 Note. Once-over tillage idea applied to pineapple production in Hawaii. AGRICULTURAL ENGINEERING, 35:875, 1954.

14 Poynor, R. R. An experimental mulch planter. AGRICULTURAL ENGINEERING, 31:509-510, 1950.

15 Rai, K. D., Raney, W. A. and Vanderford, H. B. Some physical factors that influence soil erosion and the influence of aggregate size and stability on growth of tomatoes. Soil Sci. Soc. Amer. Proc., 18:486-493, 1954.

16 Sprague, M. A. Substitution of chemicals for tillage in pasture renovation. Jour. Amer. Soc. Agron., 44:405-409, 1952.

17 Wilson, H. A. and Browning, G. M. Soil aggregation, yields, runoff and erosion as affected by cropping systems. Soil Sci. Soc. Amer. Proc., 10:51-57, 1945.

18 Yoder, R. E. The significance of soil structure in relation to the tilth problem. Soil Sci. Soc. Amer. Proc., 2:21-23, 1937.

19 Zwerman, Paul J., Page, J. B. and Yoder, R. E. Soil structural stability of Brookston clay as a factor in sugar-beet yields. Soil Sci. Soc. Amer. Proc., 17:159-164, 1953.

Watershed Planning

Eugene C. Buie
Member ASAE

A consideration of land-treatment measures, prevention of flood damage, water storage, soil and water conservation, and other programs

WATERSHEDS have always exerted a major influence in the development of the economy of any community, state or nation. Our forefathers frequently built their homes, settlements and cities adjacent to waterways. Often the divides between watersheds were steep and heavily forested, and travel across them was difficult, even by foot or horseback. Movement within a watershed was generally parallel to the streams, which often influenced the economy of a particular watershed. Sometimes even different customs developed within adjacent watersheds due to communication difficulties. Modern means of communication have largely overcome these conditions but watersheds continue to influence communities.

Many of today's larger cities owe much of their prosperity to advantages offered by adjacent streams. These include an adequate supply of water for municipal and industrial purposes, for power development, for transportation and for recreation. When the dependable water supply is threatened, the quality materially lowered or damaging floods occur, the economy of a city is adversely affected. This condition has long been recognized and many flood-control and multipurpose reservoirs have been created to alleviate those problems which result from erratic stream flow.

The pyramiding demands for water for municipal, industrial, irrigation, rural water supply, recreation, power, pollution abatement and many other uses are making watersheds an even greater factor in the present-day development of the economy of a particular locality. The condition of its watershed determines the character of a stream. The character of its tributary streams determines the characteristics of a river which in turn create those river-basin problems related to the control, management and use of surface waters.

For many years the primary approach to alleviating watershed problems was the use of large impounding reservoirs. These reservoirs frequently protected population centers and often provided power, navigation or other benefits. All effort was concentrated near the point of damage or direct benefit. Little or no effort was given to attacking the problem at its source.

In the Flood Prevention Act of 1944, the Congress of the United States authorized the U.S. Department of Agriculture to initiate flood-prevention activities in eleven river watersheds throughout the nation. This program is characterized by treatment of the watersheds to improve infiltration rates, reduce erosion and resultant sediment production, protect fertile flood plains from frequent flood damage so that they can be utilized more intensively, and convert upland used beyond its capability to proper use.

Paper presented at a meeting of the Southeast Section of the American Society of Agricultural Engineers at Memphis, Tenn., February 1959.

The author — EUGENE C. BUIE — is watershed planning specialist, engineering and watershed planning unit, Soil Conservation Service, USDA, Spartanburg, S. C.

Needed land conversions are made possible by the protection afforded flood plain areas. Many of these flood plain lands have become unsuited for continued agricultural use because of frequent floodwater and sediment damage. The correction of this condition permits these lands to be re-established in agricultural use. Comparable areas of cultivated upland which are less suited to clean-tilled crops can then be planted to grass or trees without an adverse affect on the economy of the individual farmers concerned.

An excellent example exists in the Piedmont physiographic area of the Southeast. As recently as 40 to 50 years ago, many of the creek flood plains were in cultivation. Harvesting timber from the upland and cultivation of much of the hill land in clean-tilled crops increased both runoff and sediment production. Sediment choked the stream channels, reducing their capacities. The resulting larger, more frequent flood flows and the reduced-channel capacities combined to create such frequent damage to crops grown in the flood plains as to make their continued use for this purpose uneconomical. Consequently additional upland acres were placed in cultivation to replace those lost in the flood plain and the problem was further aggravated. This condition can be reversed only through the watershed-protection and flood-prevention approach.

The results of the flood-prevention program being applied in the eleven authorized watersheds were so effective and so popular that Congress amended its agricultural appropriation act of 1953 to permit the establishment of 62 pilot watershed protection projects outside the authorized river watersheds. Then in 1954 Congress passed the Watershed Protection and Flood Prevention Act (PL-566) which was amended in 1956 by PL-1018 and in 1958 by PL-85-865.

The Watershed Protection and Flood Prevention Act, as amended, is administered by the Department of Agriculture and should not be confused with the Small Watersheds Act which is applicable only to the western states and is administered by the Department of the Interior. The Secretary of Agriculture has designated the U.S. Soil Conservation Service as the agency within the Department of Agriculture with primary responsibility for carrying out the provisions of the Act. The U.S. Forest Service has been delegated the responsibility for providing technical guidance in planning and operations on all forest land.

A watershed project is the product of local initiative. The local people recognize their watershed problems, determine the objectives they wish to accomplish, initiate an application for assistance, and work closely with the Soil Conservation Service in developing the plan. To be eligible for assistance, a watershed must have a total area of less than 250,000 acres and have problems requiring group action which cannot be corrected under other going USDA programs. For high priority of consideration, the watershed

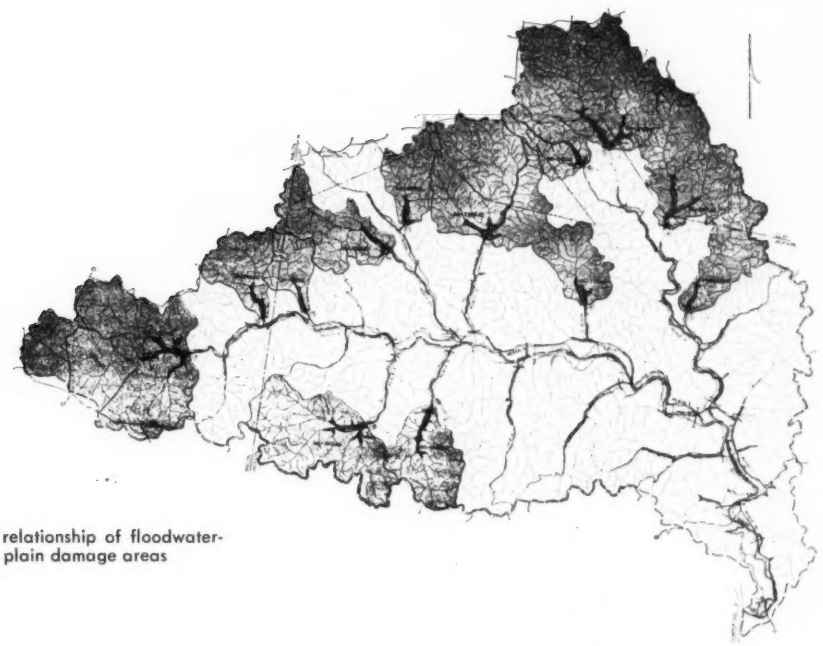

Fig. 1. Typical watershed showing relationship of floodwater-retarding structures to flood plain damage areas

project should have multiple purposes, including watershed protection.

Watershed protection is the first element of consideration in planning a watershed project and it is the first increment of evaluation. The needs of the watershed are analyzed and the appropriate land-treatment measures are selected to meet these needs. Any land-treatment measure is eligible for project assistance which will affect a measurable reduction in runoff and sediment production. Needed land conversion is one of the most important measures considered in the Southeast. These land-use changes and land-treatment measures are carried out by the landowners and operators at their own expense, utilizing such cost sharing and technical assistance as is available under going agricultural programs. Project funds may be utilized to increase the technical assistance available so as to facilitate the establishment of planned measures within the designated installation period. Proper protection of the watershed affects the character of the stream. Flood flows are less frequent and of somewhat lower magnitude and sediment loads are materially reduced.

The prevention of flood damage is usually the second watershed problem considered in planning and evaluating a watershed project. Critical runoff and sediment-producing areas contribute to flood damages. Land-treatment measures used to stabilize these areas are classed separately from those for watershed protection. In addition to technical assistance, project funds may be used to share in the cost of these measures which are frequently both vegetative and mechanical. The primary reduction in flood damage is effected by floodwater-retarding structures, improved stream channels or a combination of both.

A floodwater-retarding structure consists of a compacted homogeneous earth embankment with a vegetated emergency spillway and a principal spillway. The principal spillway consists of a conduit through the embankment with a vertical riser on the upstream side. These risers may be either single-stage or two-stage. The elevation of the crest of the single-stage riser or the lower stage of a two-stage riser establishes the bottom of the detention or flood pool. The crest of the emergency spillway establishes the top of the detention pool. The floodwater-retarding structure is designed so that the hydrograph produced by the design-frequency storm can be routed through the reservoir without emergency spillway action. The smallest storm for which a floodwater-retarding structure with a vegetated emergency spillway is designed is the 25-year-frequency storm. All costs for construction and installation services of a single-purpose, floodwater-retarding structure are provided from project funds. The local people provide the easements and rights of way and administer the construction contract.

Improved channels either alone or in combination with floodwater-retarding structures are designed to reduce the frequency of overbank flow to meet the level of protection or objectives desired by the local people within the limits of economic feasibility. Cost sharing for single-purpose flood prevention channels is the same as for single-purpose, floodwater-retarding structures.

The proposed system of floodwater-retarding structures and improved channels is evaluated to determine that the

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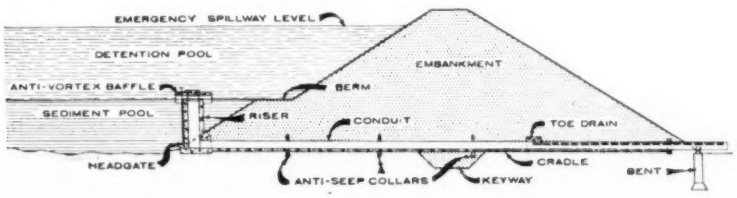


Fig. 2 Section of a typical floodwater-retarding structure

Electronic Temperature Controller

Using Thermistor Sensing Element

R. P. Prince and R. L. Barber
Assoc. Member ASAE

A NEED developed for low-cost sensitive thermostats to control temperature in four 87-cu ft poultry environmental chambers at the Connecticut (Storrs) Agricultural Experiment Station. The major factor affecting the selection or design was the ability to control temperature to within ± 0.5 F under varying relative humidities and heavy dust accumulations. Compensation for ambient temperature, cost, and the absence of open contacts within the chamber were also essential. Since the cost of commercial instruments meeting the operational characteristics and specifications was prohibitive, controllers were constructed at an actual component parts cost of less than $25 each.

Circuit Characteristics

A thermistor sensing element was used in a d-c Wheatstone bridge circuit, Fig. 1. These semiconductors are thermal resistors, or resistors with a high negative temperature coefficient of resistance. Many thermistors are available for special applications as described by Taylor (3)*. The size, time constant, and impedance of the Fenwal KA31L1 thermistor was well suited to this application.

To minimize self heating in the thermistor, the voltage across the bridge and the values of the fixed resistors, R_A and R_B, were selected in accordance with the dissipation constant of the thermistor. The value of the temperature setting resistance, R_X, was selected for the range of temperatures to be controlled. Combinations of fixed and variable resistances may be used to provide greater rotational degrees per unit temperature change.

Under normal conditions the bridge is balanced and there exists no difference of potential between points A and B. When the temperature at the sensing element needs correcting, the bridge becomes unbalanced and produces a d-c voltage between A and B. If this voltage is of the correct polarity at the input terminals of the amplifier, Fig. 2, the temperature correcting circuit is activated. Since the voltage across the bridge is d-c, reversing the leads at the input of the amplifier will cause the controller to function with either rising or falling temperatures.

A three-volt battery was used to supply voltage to the bridge. Because of the bridge design the drain on the battery was only three millamperes; thus the life of the battery is quite long. In this case the original cells were still in use after 15 weeks of operation. It would also be feasible to incorporate a rectifier circuit which would supply the necessary voltage to the bridge.

The amplifier (1) is voltage operated and built around a single 12AX7 vacuum tube and a pair of 2N109 PNP transistors. One of the inherent characteristics of the amplifier is its nonlinearity. This presents no problem since the amplifier is used to key a relay and does not operate a calibrated readout device.

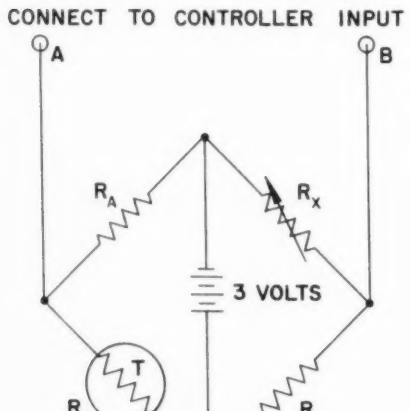
During the first 48 hours of operation some temperature drift was experienced. This was caused primarily by aging of the vacuum tube. Additional drift over an extended

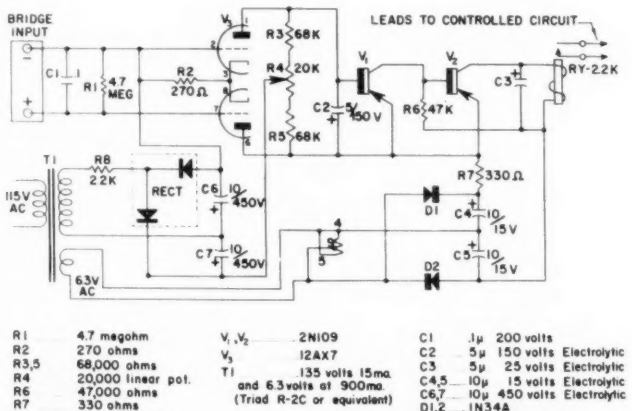
(Continued on page 108)

An Instrument News Contribution. Articles on agricultural applications of instruments and controls and related problems are invited by the ASAE Committee on Instrumentation and Controls, and should be submitted direct to Karl H. Norris, instrument news editor, 105A South Wing, Administration Bldg., Plant Industry Station, Beltsville, Md. Paper is approved for publication as Journal Article of the Connecticut (Storrs) Agricultural Experiment Station.

The authors — R. P. PRINCE and R. L. BARBER — are, respectively, assistant professor of agricultural engineering and research assistant, Connecticut (Storrs) Agricultural Experiment Station.

*Numbers in parentheses refer to appended references.





R1	4.7 megohm	V_1, V_2	2N109	C1	.1μ 200 volts
R2	270 ohms	V_3	12AX7	C2	5μ 150 volts Electrolytic
R3,5	68,000 ohms	T1	135 volts 15ma. and 6.3 volts at 900ma. (Triad R-2C or equivalent)	C3	5μ 25 volts Electrolytic
R4	20,000 linear pot.			C4,5	10μ 15 volts Electrolytic
R6	47,000 ohms			C6,7	10μ 450 volts Electrolytic
R7	330 ohms			D1,2	1N34A
R8	2,200 ohms 1 watt			RECT	130 volts 20 ma.
Note: ½ watt 10% Resistors except R8				RY	2,200 ohm coil 4ma. or less closing current (Advance SV/1C/2,200D)

Fig. 1 *(Left)* Wheatstone bridge circuit using thermistor as sensing element • Fig. 2 *(Right)* Schematic of the amplifier used to key the controlled circuit relay

. . . Drying Rate of Alfalfa Hay

(Continued from page 89)

Table 3 shows the number of hours required to dry the leaves and stems to 20 percent moisture. The leaves, the hard crushed and the "penetrated" stems dried to 20 percent in 18 to 21 hr. The alfalfa stems chopped in 2-in. length dried in 37 hr. All other treatments required more than 48 hr to reach this moisture content.

TABLE 3. HOURS REQUIRED FOR SEPARATED LEAVES AND STEMS TO REACH 20 PERCENT MOISTURE CONTENT

Item	Check	Penetrated	Smashed	Crushed	Chopped 2 in.	Chopped 6 in.	Chopped 10 in.
Leaves	19	18	21	18	21	21	18
Stems	48+	18	26	19	37		48+

Drying Time for Complete Plant and Separated Leaves and Stems

The results of the above-mentioned experiments were evaluated to determine the total evaporation curves for leaves plus stems dried separately. These were compared with those obtained from alfalfa plants dried as a whole plant and are shown in Fig. 12. All the treatments indicated that the drying time was the same for alfalfa hay, whether the leaves were dried together with the stems or were dried separately.

Sectional Drying Rates for Alfalfa for Different Degrees of Crushing

In order to determine the path of the water movement in the alfalfa stem during the drying process at different degrees of crushing the following three treatments were applied to alfalfa plants:

(a) Uncrushed

(b) Crushed (similar to that by a commercial hay crusher)

(c) Hard crushed (considerable amounts of juice appearing on the stem surface)

In order to get uniform drying conditions throughout the drying time, the experiment was conducted in a controlled atmosphere – 84 F and 59 percent relative humidity. Immediately before each moisture determination the leaves were separated from the stems, and the remaining stems were divided into four groups according to distance from the top end of the stem. The stem pieces from the different groups were collected and the moisture content was determined separately for each stem section.

The results obtained from this experiment are shown in Table 4. The data indicate that both degrees of crushing increased the drying rates of stems as well as leaves. The drying rates of the stems were, however, increased considerably more than that of the leaves. The experiment shows that the moisture movement in the stem was mainly

TABLE 4. THE MOISTURE CONTENT IN DIFFERENT SECTIONS OF ALFALFA PLANT THROUGHOUT THE DRYING TIME

Hours of drying	Treatment	Section of plant (inches from top)				
		Leaves	0-6	6-12	12-18	18-22
		Percent moisture (wet basis)				
0	Uncrushed	70.2	72.2	70.7	69.3	66.8
2	Uncrushed	67.1	67.7	67.3	66.1	57.6
	Crushed	67.6	67.2	65.1	60.3	60.1
	Hard crushed	66.1	57.8	57.4	52.7	53.4
7	Uncrushed	63.7	64.5	63.8	62.0	55.1
	Crushed	59.1	61.6	60.1	59.6	56.4
	Hard crushed	47.4	37.4	34.9	22.0	25.9
12	Uncrushed	61.7	63.3	62.0	61.3	54.0
	Crushed	49.0	50.4	43.2	39.6	37.2
	Hard crushed	32.9	25.1	17.0	10.9	9.7
23	Uncrushed	37.8	49.8	49.6	46.9	46.8
	Crushed	31.7	30.4	25.6	14.9	15.4
	Hard crushed	18.3	16.3	11.7	10.4	9.9
28	Uncrushed	25.5	46.0	45.9	39.2	32.1
	Crushed	26.3	30.6	23.1	11.2	11.6
	Hard crushed	11.4	11.0	10.2	10.1	9.7
48	Uncrushed	12.9	37.5	39.7	35.1	22.6
	Crushed	9.2	14.4	14.0	10.9	8.7
	Hard crushed	8.4	8.7	8.4	7.3	7.2
144	Uncrushed	7.7	7.8	7.6	7.6	7.7

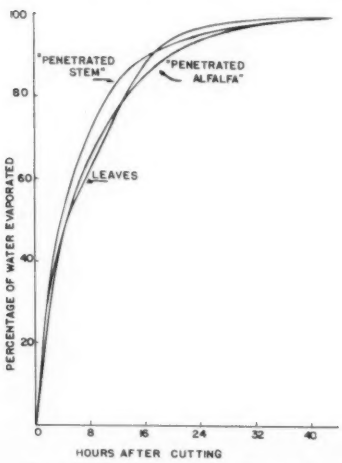


Fig. 10 Drying curves for "penetrated" alfalfa when stems and leaves are dried separately

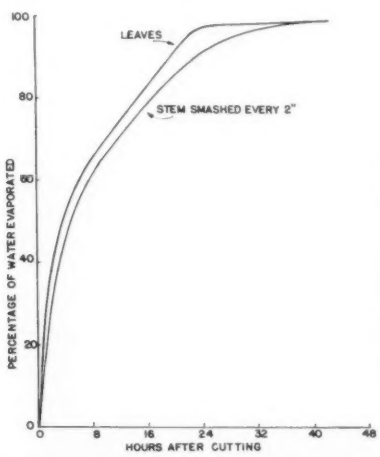


Fig. 11 Drying curves for alfalfa with stems smashed every 2 in. when leaves and stems are dried separately

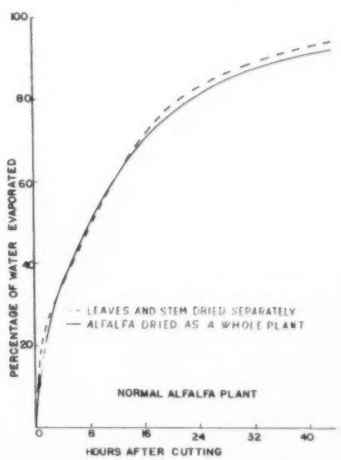

LEAVES AND STEM DRIED SEPARATELY
ALFALFA DRIED AS A WHOLE PLANT
NORMAL ALFALFA PLANT
PERCENTAGE OF WATER EVAPORATED
HOURS AFTER CUTTING

Fig. 12 Drying curves for normal alfalfa plant

radial; only in the case of the uncrushed alfalfa did a small longitudinal movement take place. For this treatment the difference in moisture content between the upper and lower part of the stem was 9.5 percent at the time of cutting, while the difference for the same sections of the plant was 14.9 percent after 48 hr of drying; and, furthermore, at the latter time the highest moisture content occurred in the middle section of the plant.

The experiment also showed that, when the crushing was severe, it was possible to dry the stems faster than the leaves. This is evident in the case of hard crushing.

Summary and Conclusions

Because hay is the most important forage crop in the United States, it is important to develop a method of curing the hay to avoid high losses.

In order to increase the drying rates of the stems, different treatments were applied to alfalfa plants. The experiments showed that fastest evaporation was obtained when the stems were hard crushed, or when the stems were penetrated several places per inch of length. Lower rates were recorded when the stems were twisted, smashed or cut in pieces of 2 in. in length.

When the hay was crushed, the drying rate of the leaves as well as that of the stems was increased. This increase, however, was considerably higher for the stems than for the leaves. If "hard crushing" was applied, the stems dried faster than the leaves. It is thus evident that a complete breakup of the cuticle causes the stems to dry faster than the leaves.

Nearly all the stomata were closed after three hours of drying. After this period the drying rate decreased considerably and stayed nearly constant until equilibrium with the surrounding air was obtained.

The younger the alfalfa plant was cut, the higher the moisture content. The highest moisture content in the alfalfa plant was found in the growing parts of the plant.

References

1 Briggs, L. J. and Shantz, H. L. Hourly transpiration rate on clear days as determined by cyclic environmental factors. J. Agr. Res., 5:583-651, 1916.

2 Briggs, L. J. and Shantz, H. L. Daily transpiration during the normal growth period and its correlation with weather. J. Agr. Res., 7:115-213, 1916.

3 Darwin, F. The effect of light on the transpiration of leaves. Proc. Roy. Soc., B, 87:281-299, 1914.

4 Loftfield, J. V. G. The behavior of stomata. Carnegie Inst. Wash. Pub. 314, 1921.

5 Mariana, G. The influence of humidity on the formation and development of stomata. Separate from ATT. Bot. Univ. Pavia 2 ser., 8:32; expt. Sta. Rec. 14:943, 1902.

6 Miller, E. C. Some observations on the stomata of crop plants. Unpublished data. Kansas State University, 1928.

7 Reed, H. S. and Hirana, E. The density of stomata in citrus leaves, J. Agr. Res., 43:209-222, 1931.

8 Thomas, M. D. and Hill, G. R. The continuous measurements of photosynthesis, respiration, and transpiration of alfalfa and wheat growing under field conditions. Plant Physiol., 12:285-307, 1937.

9 USDA. Grass. Yearbook of Agriculture. 161-168, 1948.

10 Pedersen, T. T. and Buchele, W. F. Hay-in-a-day harvesting. AGRICULTURAL ENGINEERING 41: in press, March 1960.

. . . Electronic Temperature Controller

(Continued from page 106)

period of time may be caused by using an unaged thermister (2).

Temperature in a poultry environmental chamber was maintained within the design range of ± 0.5 F for a period of 12 weeks with this controller. Laboratory tests using smaller chambers resulted in even smaller deviations in temperature.

Construction and Operation

With the exception of the thermistor and the sensitive relay, all components are stock items at most electronic suppliers. Construction of the unit should present no difficulty. No special tools are required but chassis punching tools will facilitate the job. All wiring is straight forward but when working with electrolytic capacitors and solid state rectifiers one must be careful to observe the correct polarity.

Before putting the controller into operation it is necessary to balance the amplifier. With the bridge connected to the amplifier input and the battery voltage removed, adjust R_1, Fig. 2, until the sensitive relay just opens. This balances the amplifier circuit with zero signal input. For controlled loads greater than 2 amperes an additional relay is required.

References

1 Hill, Bert J. Transistor and hybrid d.c. amplifiers, Radio Electronics, vol. 29, no. 7, July 1958.

2 Squires, James R. Versatile thermistor thermometer, Radio Electronics, vol. 27, no. 4, April 1956.

3 Taylor, J. G. Thermistors, AGRICULTURAL ENGINEERING, vol. 33, no. 8, August 1952.

. . . Watershed Planning

(Continued from page 105)

expected benefits will exceed the costs. In the Southeast a historical flood series, usually of about 20-years duration, is selected as the basis for this evaluation. Current flood-free damageable values within the flood plain are determined. The selected storm series is flood routed through the watershed using appropriate valley flood-routing procedures. Flood damages under present conditions are determined by damage schedules taken from farmers within the damage area. The reduction in runoff resulting from the application of land-treatment measures for watershed protection is calculated. The storm series is again flood routed using these reduced runoff figures. The resulting damage reduction is credited to the land-treatment measures for watershed protection and the remaining damages become the base for evaluating the flood-prevention measures.

The flood-damage reduction benefits effected by the land-treatment measures for flood prevention are determined similar to those for watershed protection. The effect of the proposed system of structures is then determined by an additional flood routing. Benefits accrue as a result of reduced damages to current flood plain values; from more intensive use of flood plain lands and from land enhancement made possible by protection from frequent flooding. These total benefits must equal or exceed the estimated cost of the proposed structural measures. Usually several systems of structures are evaluated before one is selected. The system selected should attain the project objectives with the minimum of total cost. *(Continued on next page)*

When irrigation and drainage are included within a project, the costs allocated to works of improvement for these purposes must be justified by the benefits which accrue from each respective purpose. If irrigation water storage is provided in a floodwater-retarding structure, the structure becomes a multiple-purpose structure and costs are allocated between purposes in accordance with the separable costs – remaining benefits procedure. If a channel provides both flood prevention and drainage benefits, it becomes a multiple-purpose channel and costs are allocated by a modification of the separable costs–remaining benefits procedure. Costs allocated to irrigation and drainage are shared by the local people in proportion to the ratio of the direct identifiable benefits to the total benefits accruing from each purpose.

Water storage for purposes which are not related to agriculture may be included in the plans for a watershed project. Municipal and industrial water supply, recreation and pollution abatement are eligible uses. Such storage may be provided either in single-purpose or multi-purpose structures. Costs of multiple-purpose structures are allocated to purposes in accordance with the separable costs – remaining benefits procedure. None of the costs allocated to non-agricultural purposes may be provided from project funds.

Under the provisions of PL-85-865, which amends PL-566, improvement of wildlife habitat may be included as a purpose. Federal participation in costs allocated to this purpose may not exceed 50 percent of the installation costs.

The provisions of PL-566 as amended offer many advantages to the people within a watershed. An inducement and further incentive is provided for establishing needed land-treatment measures for watershed protection. A coordinated, interrelated, objective-type plan is provided within which these measures can be applied. In addition, project cost-sharing for stabilization of critical runoff and sediment producing areas, where needed, permits a landowner to complete the conservation treatment on his farm which he normally cannot do under other going programs. The protection of flood-plain lands and the provision for irrigation and drainage permit more intensive use of many areas in accordance with their capabilities. Needed land-use adjustments can be made which would not otherwise have been possible. Works of improvement installed under this program will reduce sediment damage and extend the useful life of downstream reservoirs, channels, and harbor improvement. Likewise, they will complement the soil and moisture conservation measures installed under the provisions of other soil and water conservation programs of the Department of Agriculture. The watershed program is indeed a boon to current agriculture as is reflected by the 1,241 applications for assistance received and the 212 watershed projects approved for operations prior to Jan. 1, 1960.

Following are brief reviews of papers presented at ASAE meetings or other agricultural engineering papers of which complete copies are available. ASAE members may obtain copies of these papers without charge by returning order forms supplied upon payment of membership dues. Nonmembers, and members requesting more than 10 copies, may purchase papers at 50 cents each to cover carrying charges from the American Society of Agricultural Engineers, St. Joseph, Mich.

The Dynamic Behavior of Farm Tractors, by J. P. Raney and J. B. Liljedahl, and R. Cohen, respectively, associate professor of mechanical engineering, University of Virginia, Charlottesville, Va., associate professor of agricultural engineering and associate professor of mechanical engineering, Purdue University, Lafayette, Ind. Paper presented at the Winter Meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 1959, on a program arranged by the Power and Machinery Division. Paper No. **59-612.**

This paper deals with the derivation, based on certain assumptions, of a set of equations of motion for an ordinary, unsprung farm tractor. The linearizing assumptions are discussed in detail. Also discussed are the methods of evaluating the necessary system parameters, such as mass moment of inertia of the tractor and dynamic spring rate of the tires, as well as the results. Also discussed is the expediency of using an electronic analog computer for the solution of the system equations, plus some of the solutions.

Dual-Monochromator Spectrophotometer for Agricultural Applications, by G. S. Birth, associate agricultural engineer, Agricultural Marketing Service, USDA, Beltsville, Md. Paper presented at the Winter Meeting of ASAE, at Chicago, Ill., December 1959, on a program arranged by the Electric Power and Processing Division. Paper No. **59-907.**

This paper describes the dual-monochromator spectrophotometer that has been developed, as a research tool, for making measurements of optical density differences for agricultural products, such as intact tomatoes, apples, or other biological tissue. The optical portion consists of two monochromators operating from the same source. Light beams from both monochromators are focused on the sample; a chopper rotating at 1000 rpm allows just one beam to impinge on the sample at a time. The energy detector is a multiplier-type phototube. The high voltage for this tube is supplied by a constant current supply (the voltage varies in direct proportion to the optical density of the sample under this condition). A switch synchronized with the chopper charges two capacitors proportional to the phototube voltage for the two light beams. Measurement of the voltage difference between these capacitors with a high impedance transistorized voltmeter indicates the optical density difference of the sample. The instrument has noise and sensitivity such that an optical density change of 0.001 can be detected. This high sensitivity enables the instrument to indicate extremely small quantities of pigments in intact peaches or similar samples. A calibration curve of the chlorophyll content of peaches is included. Curves demonstrating the detection of a photoresponsive compound present in minute amounts in living plant tissue are shown also.

Factors to Consider in Laying Out Graded Furrow Irrigation Systems in Sugar Cane Fields, by E. M. Norum, assistant project engineer, field engineering dept., Hawaii Sugar Planters Association, Honolulu. Paper presented at a Hawaii Section meeting in October, 1959. Paper No. **59-232.**

The persons charged with the responsibility of determining the most economical field layout do to a large extent determine the margin of profit on an irrigated plantation. A layout once decided upon must be used for from two to 10 years. Needless to say decisions in this area are reviewed by all concerned. During the course of the planning and review a number of well defined areas must be considered as contributing certain design considerations. This paper covers the following factors to consider when laying out graded furrow irrigation systems: Rainfall, topography, agronomic considerations, irrigation system, and mechanical operations. It also gives specific design information, where it is available, in the various areas; otherwise, it discusses them in a general manner.

A Successful Hog Finishing Facility—Building Layout and Design, by T. J. Brevik, extension agricultural engineer, University of Wisconsin, Madison. Paper presented at the Winter Meeting of ASAE, at Chicago, Ill., December 1959, on a program arranged by the Farm Structures Division. Paper No. **59-801.**

This paper discusses the kind of facilities for hog raising that is under study in Wisconsin. In particular, it discusses the performance of a hog finishing house that was designed, built, and operated under farm conditions. This 6-pen house is open to the south, divided into pens that are 28 feet wide, and 40 feet deep. A draft-free bedded area is provided at the back of the pen, mechanical manure removal, automatic feeding, and a sorting-service alley and scale house is provided for convenient and efficient management. Plans are shown of the existing house, plus a plan which incorporates suggested improvements in the existing house.

Continuing Demand for Agricultural Engineers

During January, the demand for agricultural engineers, as reflected by the Society's Personnel Service, continued at the high level shown for 1959. Several new listings have been added and no employers listed in December have reported all of their openings filled, although some of the employers listed have located and employed some of the agricultural engineers needed.

As noted editorially in AGRICULTURAL ENGINEERING for January (page 19) demand is highest for men qualified for design and development work on mechanical farm equipment. The next highest unsatisfied demand is for men qualified by advanced study for highly technical research in various branches of agricultural engineering.

The Society Council, at its meeting in Chicago in December (reported on page 85 in this issue) considered the high demand for agricultural engineers and suggested that all members and employers concerned be encouraged to emphasize the opportunities represented, for individual agricultural engineers and for the profession.

Some ways in which the supply of agricultural engineers can be increased have been outlined by the ASAE Committee on Student Recruitment. A few of their suggestions, which many members can help carry out, are as follows:

1 Sections should encourage members to be available to speak at high school career days, service clubs, farm groups, etc., about career opportunities.

2 Sections might supply copies of the "Student Journal" or AGRICULTURAL ENGINEERING to be placed in selected high schools.

3 Sections and companies might provide scholarships for agricultural engineering students and properly publicize these.

4 Sections, companies or individuals might sponsor student paper awards competitions and provide prizes.

5 Sections and companies might provide and distribute career leaflets, slide sertes, and movies on career opportunities in various branches of agricultural engineering.

6 Sections can invite students to section meetings whenever such attendance will not interfere with the students' class schedules.

7 Individual members may consider the "big brother" system of sponsoring the costs for individual students to attend Section meetings.

8 Sections should publicize at the local level the outstanding accomplishments of their member agricultural engineers.

9 In advertisements, especially in publications likely to be read by students, companies could feature career opportunities for agricultural engineers within the company.

10 Whenever a company makes up an ad featuring career opportunities in agricultural engineering as suggested above, reprints should be made available to agricultural engineering departments and the ASAE office so that prospective students might see tangible evidence of the demands for agricultural engineers.

11 See that employment interviewers are acquainted with the training and work of the agricultural engineer so that they will know what places in his organization these men can fill.

12 When company representatives are recruiting in colleges and universities, they should specifically ask to interview agricultural engineers.

13 Interested companies might consider listing in certain career booklets and indicate their needs for agricultural engineers along with other engineers or other professional employees.

14 In communities where a company has a plant, invite guidance counselors in to show them the facilities of the company and explain opportunities for employment and the kinds of work performed by agricultural engineers.

15 Offer more summer jobs to agricultural engineering students.

16 Members and agricultural engineering departments should make use of the ASAE movie and leaflets, whenever talking to groups or when contacting individuals.

Tau Beta Pi Fellowships

Announcement has been made of the 27th Annual Program of Tau Beta Pi Fellowships, including the Charles H. Spencer Fellowship, the Honeywell-Tau Beta Pi Fellowship, and Alumni Fellowship No. 3, for graduate study in engineering during the school year 1960-61. Up to five awards will be made, each in the amount of $1800 in cash — payable in ten monthly increments. All Tau Beta Pi members are eligible, including members already graduated, whose applications will receive full consideration. The deadline for filing applications is February 29, 1960, and additional information may be obtained by writing to Paul H. Robbins, director of Fellowships, 2029 K St., N.W., Washington 6, D.C.

Landmaster, Inc. Opens First American Office

Announcement has been made that Landmaster, Inc., opened its first American office for merchandising farm equipment in January of this year. Landmaster is a member of the Firth Cleveland group, a British organization of 56 companies whose products range from ships and steel through precision instruments and equipment for atomic energy. Current plans call for the company to ship partly-assembled agricultural machinery to this country from the company's British factories. American gasoline engines and other fittings will be installed here. Other American engines and parts will be shipped to England for use in Landmaster products for sale in other countries.

ASAE MEETINGS CALENDAR

February 17 — CONNECTICUT VALLEY SECTION, Yankee Pedlar Inn, Holyoke, Mass.

February 23 — IOWA SECTION, Hotel Fort Des Moines, Des Moines, Iowa.

February 25 — CENTRAL ILLINOIS SECTION, Shrine Mosque Auditorium, Peoria, Ill.

February 25-26 — NORTH CAROLINA SECTION, and a *Symposium for Industry Related to Agriculture*, Agricultural Engineering Bldg., North Carolina State College, Raleigh.

March 3-4 — SOUTH CAROLINA SECTION, Clemson College, Clemson, S. C.

March 4 — QUAD CITY SECTION, American Legion Club, Moline, Ill.

March 24-25 — SOUTHWEST SECTION, Washington-Youree Hotel, Shreveport, La.

April 1-2 — ROCKY MOUNTAIN SECTION, New Mexico State University, State College, N. M.

April 8-9 — MID-CENTRAL SECTION, Hotel Robidoux, St. Joseph, Mo.

April 14-15 — PACIFIC COAST SECTION, Arrowhead Conference Center of the University of California.

April 22 — QUAD CITY SECTION, American Legion Club, Moline, Ill.

May 6 — MICHIGAN SECTION, Battle Creek, Mich. Further details later.

June 12-16—ANNUAL MEETING, Ohio State University, Columbus, Ohio.

August 22-23—NORTH ATLANTIC SECTION, University of Massachusetts, Amherst.

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.

J. A. Waller, Jr. *(center)* and P. B. Potter *(right)* were presented with certificates of appreciation by E. T. Swink, head of the agricultural engineering department of Virginia Polytechnic Institute, on behalf of the department staff, at a banquet held at the VPI Faculty Center on January 22. Both men have retired recently from the department, with a combined service to their credit of almost 70 years and are both life members of ASAE having joined the Society in 1922 and 1916, respectively. J. A. Waller, an extension engineer, is best known for his work in areas of drainage, irrigation, water systems, and 4-H activities. He was a pioneer in the establishment of rural power lines in Virginia during the early twenties. J. B. Potter served for many years on the teaching staff of the department and in recent years has done research with the Virginia Agricultural Experiment Station. Many of the buildings currently used at various branch experiment stations were designed by him.

D. E. Washburn

J. T. Clayton

Joe T. Clayton, associate professor of agricultural engineering at the University of Massachusetts, has been awarded a Science Faculty Fellowship, by the National Science Foundation. The award covers a 15-month period starting in September, 1960. He plans to take leave from his current position to do advanced study towards a doctorate in agricultural engineering at Cornell University.

D. E. Washburn recently has accepted a position as vice-president and general manager of the Royersford plant of the John Wood Company. He has had broad experience in the manufacture of milk coolers prior to coming with John Wood and is experienced in sales and engineering. He is a graduate agricultural engineer of Ohio State University and has had additional work at the University of Tennessee and the University of California. He has formerly occupied responsible positions with Tennessee Eastman Corp., Tennessee Valley Authority and, just prior to coming to John Wood, has been with United Co-Operatives, Inc. for 13 years.

John H. Muller has been appointed sales manager of irrigation products for Farmland Irrigation Co., San Jose, Calif. Mr. Muller, who recently left his post of sales manager at Buckner Manufacturing Co. of Fresno, Calif., is rejoining the company he served from 1951 through 1954, when he was a field representative. His experience within the industry also includes managing a sprinkler irrigation equipment wholesale organization for five years, beginning in 1946, and was highlighted by a world tour made in 1959 to observe and study sprinkler irrigation equipment and practices in Australia, Africa, Europe, England, and the Scandinavian countries.

John G. Adams is now located in Roswell, N. M., as foreman of a laying crew for Gifford-Hill-Western, Inc., who deal in concrete irrigation pipe. Formerly he was associated with the Soil Conservation Service, USDA, in Sweetwater, Texas.

Elvan L. Bean, formerly agricultural engineer for B & M Wholesale, has accepted the position of area sales representative for Washington Turf and Irrigation, Seattle, Wash., distributors of turf maintenance and irrigation equipment.

M. L. Taneja advises that he is now located in Cuttack, India, as an agricultural engineer with the Central Rice Research Institute. Two of his major assignments include mechanizing rice cultivation and undertaking trials and research in the development and introduction of improved implements and machines, as well as hand tools. He formerly held the position of assistant engineer with the Tractor and Agricultural Machinery Utilization Training Centre in Budni (Bhopal), India.

NECROLOGY

Robert L. Worrell, project engineer, Allis-Chalmers Mfg. Co., died on December 19 at the Holy Family hospital in LaPorte, Ind. He had been for many years, and up until the time of his death, associated with the engineering department of the company's LaPorte Works. His association began with the Advance-Rumely Co., in 1927, who were the predecessors of Allis-Chalmers Mfg. Co. For the past 20 years he had been in charge of grain harvester engineering under the chief engineer at the LaPorte Works. He was born September 26, 1904 in Canton, Ill., and attended the University of Illinois and Purdue University.

R. B. Worrell

In 1952-53 he served as chairman of the ASAE Power and Machinery Division. He had long been active on Farm Equipment Institute engineering subcommittees, and was chairman of the subcommittee in charge of Safety Shielding on Combines. He was active in the First Methodist church in LaPorte, the Masonic lodge of Walkerton, and the A-C Foremen's club.

In 1931 he was married to Mary Wineholt, who survives. A son, Robert P., is a law student at Indiana University.

Sylvanus D. Locke, Jr., life member of ASAE, died on September 27, 1959, at the age of 88. The son of an illustrious inventor, he was born in Hoosick Falls, N.Y., in April, 1871. His father was credited with being one of the first to invent a grain binder, which was produced by the Walter A. Wood Co., Hoosick Falls and widely used in the harvest of 1877-80. The elder Locke's interest in steel chain led him, in 1888, to file patents for a method of making drive chains, a die for making drive chains, and a new improvement in drive chains. The unique feature of the chain, then as now, is that it is stamped from a single strip of steel and that it employs all of the metal in its design.

The younger Locke took this invention, after the death of his father, and organized The Locke Steel Belt Co., a West Virginia corporation, in 1897. Experimental work began in small factory quarters in Brooklyn, and in 1899 space was rented in Bridgeport, Conn., and production started in earnest. Having attended Cornell University for two years, he succeeded in interesting eight associates, all Cornell men, to join the company either as officers or directors. Under his direction the company's product was adapted for use in such equipment as woodworking and textile machinery, conveying and elevating machinery for handling ore, coal, and grain, in addition to its many and varied uses in agricultural machinery. The name of the Locke Steel Belt Co. was changed in 1917 to Locke Steel Chain Co., and in May, 1957, the Chain Division was moved to Huntington, Ind. The former Chain plant now houses the Lawn Mower Division.

S. D. Locke, Jr. served the company long and faithfully until his death. He was very active in civic life in the City of Bridgeport, having been a member of various boards from 1932 to 1957. He was the last of the original Locke family.

Everett H. Davis advises that he now is located in Calcutta, India, as a drainage engineer for the University of Missouri, Technical Cooperative Mission to India. Previously he was an extension agricultural engineer at the University of Idaho, Moscow.

Herman Bouwer has accepted a position with the newly established Southwest Water Conservation Laboratory, ARS, USDA, at Tempe, Ariz. He was formerly associated with the Department of Agricultural Engineering at Auburn University, Auburn, Ala. In his new position he will continue his research in the field of water management engineering, particularly on problems involving unsaturated flow.

A. Myron Howell has resigned his position as district sales manager, northeast area, John Bean Division, Food Machinery and Chemical Corp., to accept the position of project engineer for the Near East Foundation, New York City. The project with which he is concerned is located in Rasht, Iran, and is for the construction of an agricultural school for the Ministry of Education and will have 20 buildings when completed in 1961.

James B. Carlton, who has been associated with R.E.A. Cooperative as a rural engineer, advises that he is presently connected with Jackson Electric Membership Cooperative in Jefferson, Ga., as a rural engineer.

Merlin K. Chapin has left Comet Manufacturing Co., where he was vice-president of engineering, to become project engineer for Lennox Industries, Inc. of Des Moines, Iowa.

Samuel J. Coughran advises that he is now associated with Rome Plow Co., Cedartown, Ga., as a design engineer. Prior to this change he was employed, for several years, by Towner Manufacturing Co.—first as a design engineer and later as assistant chief engineer.

Francis E. Gilman has accepted a position as agricultural engineer with the New England Electric System in Clinton, Mass. He formerly was employed by The White Metal Rolling and Stamping Corp. as a sales engineer.

Lloyd E. Gustafson is now associated with Minneapolis-Moline Co. in Hopkins, Minn., as a design engineer. He previously held the position of design engineer with Superior Separator Co.

Roy J. Howard, who formerly held the position of plant engineer with Charles M. Cox Co., is now located in St. Albans, Vt., where he is an assistant supervisor with St. Albans Grain Co.

Charles W. Kellogg advises that he is now self-employed as a partner and manager of The Clark Farms, Conneaut, Ohio. He previously was senior product engineer with the New Idea Farm Equipment Co., Div. of Avco Mfg. Corp.

Connecticut Valley Section

On February 17, the Connecticut Valley Section will hold a 6:30 p.m. dinner meeting at the Yankee Pedlar Inn, Holyoke, Mass. L. H. Skromme, president of ASAE and chief engineer of New Holland Machine Co., will be the featured speaker on the program following the dinner. His subject will be new farm machinery developments.

Quad City Section

The Quad City Section held its 1960 Technical Series meetings at the Iowa-Illinois Gas and Electric Co. auditorium, 2811 Fifth Ave., Rock Island, Ill. These meetings included three evening sessions as follows: On January 29, Grant Thomas, Foundry Section of Material Engineering Dept., Deere & Co., spoke on casting design, and Earl McCullough, metallurgical engineer, Deere & Co., discussed machining of castings; "Arc Welding of Gauge Material and Related New Procedures" was the topic of a talk by C. A. Hefferman, assistant regional sales manager, Lindy Co., Division of Union Carbide Co., on February 5; Walter Hanneman, executive engineer, Shakeproof Division, Illinois Tool Works, covered the subject of design of fasteners for production on February 12.

Iowa Section

The Iowa Section will hold a meeting on February 23 at the Hotel Fort Des Moines, 10th and Walnut Streets, Des Moines, Iowa. This will be in the form of a joint 7:00 p.m. dinner meeting with the Iowa Engineering Society, which has scheduled a two-day meeting at that time. The new and intriguing fuel cell tractor and developments in the professionalism in engineering will be the program subjects, which will be of interest and importance to all agricultural engineers. Professionalism is for all engineers will be discussed by H. Robert Veenstra, Stanley Engineering Co., Muscatine, Iowa, and Patrick Grimes, research engineer, Allis-Chalmers Mfg. Co., Milwaukee, Wis., will speak on the fuel cell tractor.

The Iowa Section also held a meeting on January 8, which was a dinner meeting at the McNeil Hi-Way Hotel, in Northwest Des Moines. The two featured speakers on the program following the dinner were Othie R. McMurray, director, Iowa Natural Resources, whose subject was "How Iowa's Water Resources Affect You," and Harold L. Brock, director of research, John Deere Research and Engineering Center, who chose as his topic "The Last Billionaire and I."

Central Illinois Section

The Central Illinois Section invites members and guests to attend a special meeting on February 25, arranged by the Peoria Engineering Council, of which the Section is a member, in connection with National Engineers' Week February 21-27. A 6:30 p.m. dinner meeting at the Shrine Mosque Auditorium, 207 N.E. Monroe, Peoria, Ill., is being planned. Col. David W. Alexander of the U.S. Air Force will be the featured speaker, and his topic will be "Outer Space and Man's Ability to Conquer and Control It."

North Carolina Section

North Carolina Section will hold a two-day meeting which will include the second annual Symposium for Industry Related to Agriculture and its regular Winter Meeting at the North Carolina State College Agricultural Engineering Building, February 25 and 26. Scheduled for the morning session of the Section meeting February 26 are discussions on grass vs. mechanical harvesting of cotton; the Research Triangle Institute and agricultural industry; machinery needs in the conservation program; and the use of weather bureau data for estimating water availability. Subjects for the afternoon session include: "The Future Design of Farm Buildings"; and "Environmental Effects on Human Performance."

The Symposium for Industry Related to Agriculture is directed mainly toward the farm machinery industries within and around North Carolina and will be held February 25. The topics to be covered during the morning session of the Symposium are: "Agribusiness"; "Tobacco Production"; "Peanut Production"; "Hay Production"; and "Materials Handling Equipment." The Symposium luncheon address will be given by W. C. Bell, head, Industrial Experiment Program, North Carolina State College, who will speak on the industrial experiment program at North Carolina State. The afternoon session will include the subjects of waste separation systems; harvesting of fruits and vegetable crops; processing equipment for fruits and vegetables; trends in the production of vegetable crops; creative planning in design and development; automation of agricultural equipment; and looking ahead in agricultural production technology.

South Carolina Section

The South Carolina Section will hold a meeting on March 3 and 4, at Clemson College, Clemson, S. C. A program is being set up covering all phases of agricultural engineering.

New AE Building Dedicated at South Dakota State

Over 500 attended the dedication ceremonies for the new Agricultural Engineering Building at South Dakota State College, Brookings, on January 19. Brooks McCormick, executive vice-president of International Harvester Co., Chicago, Ill., gave the dedicatory address at the afternoon ceremonies, which were followed by inspection tours of the building. In conjunction with the dedication ceremonies, the student branch of ASAE held its annual banquet in the evening, at which L. H. Skromme, national president of ASAE, was the speaker. Approximately 150 attended the banquet, including H. M. Briggs, president of the College, M. L. Manning, dean of engineering, O. G. Bentley, dean of agriculture, and Miss Dona Brown, member, Board of Regents of Education for the State of South Dakota.

The new building includes a general office; 17 staff offices; graduate office section; five general classrooms; a large classroom auditorium (seating 214); a large demonstration classroom (seating 125); technical reading room; drafting and blueprint rooms; 10 research laboratories for Power and Machinery; Farm Structures; Soil and Water; Rural Electrification; Crop Processing; and Weather Modification; design rooms; teaching laboratories; large two-story fluid mechanics laboratory; general shop; tool room; instrumentation room, and weather station facilities.

Flail-chop "pasture" faster ...cut silage shorter!

New low-cost McCormick® No. 5 chopper

Take a short-cut to lower-cost forage feeding with a new McCormick auger-blower chopper. No other flail-type rig slices silage so short . . . makes it so quick and easy to feed your livestock cut-pasture in dry lots.

Two-dozen *extra* knives—56 in all—plus faster rotor speed give the No. 5 over 45% more cutting action than other flail-choppers! Exclusive tandem mounting gives knives a double swipe at hay stems. They're cut, recut . . . then augered into the high-speed blower.

Four knives and blower paddles, instead of the usual three, chop long lengths into little ones, and blow them into trailing wagon. Use the No. 5 for green-chop or silage, and dozens of other cutting and shredding jobs.

New McCormick No. 5 Direct-Throw model is your low-cost chopper for daily green-chop chores. Extra-wide, cup-shaped knives, mounted in tandem, double-cut forage into feedable lengths, then throw it far back into the wagon.

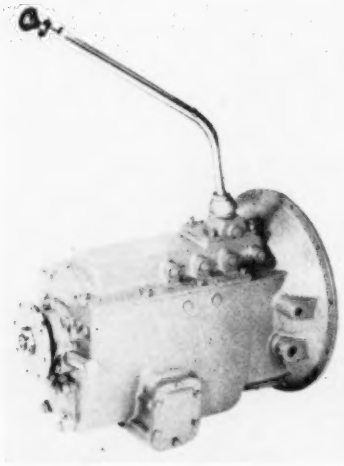
Ask your IH dealer to demonstrate a McCormick flail-type chopper in your crop. Ask about the IH Early Trader's Bonus that pays 6% interest on your trade-in and/or down payment.

See your **INTERNATIONAL HARVESTER** dealer

International Harvester Products *pay for themselves in use*—Farm Tractors and Equipment . . . Twine . . . Industrial Tractors . . . Motor Trucks . . . Construction Equipment—General Office, Chicago 1, Illinois.

New 5-Speed Transmission

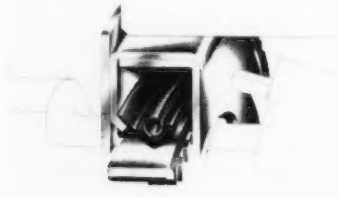
Dana Corporation, Transmission Division, Toledo 1, Ohio, has developed a new compact, 5-speed synchronized heavy-duty



transmission for off and on highway use. The new unit, known as the 5000 series, is particularly applicable where engines call for large capacity transmissions and minimum overall size is preferred. The new unit is a modification of the 4000 series, in which several internal components have been redesigned and the torque range rating increased from 375 to 450 ft-lb. It weighs 295 lb and measures $24^{11}/_{16}$ in. in length.

New Unitized Oil Seal

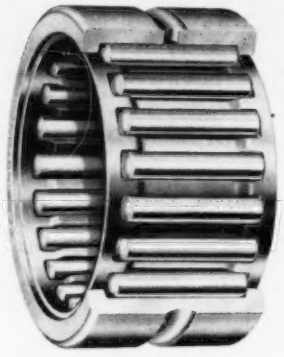
National Seal Division, Federal-Mogul-Bower Bearings, Inc., Redwood City, Calif., has introduced a new "unitized" oil seal



which contains a wear sleeve as an integral part of the seal itself. The self-contained wear sleeve has an inside surface made of rubber and an outside surface of specially-prepared, polished metal. The sleeve turns with the shaft, thereby allowing the lip of the seal to run on the metal sleeve rather than on the shaft itself. The manufacturer reports that the built-in wear sleeve makes it possible to eliminate variables and to control the sealing environment. The new seals will be available in varying sizes and for both single or double lip applications, it is said, and they can also be manufactured in a variety of combinations, including special designs and various synthetic compounds.

New Roller Bearing Features Special Cage Design

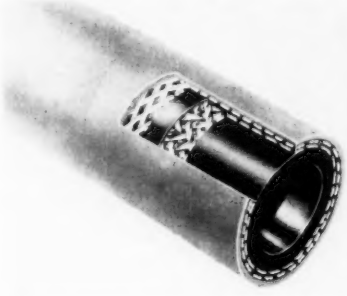
The Torrington Co., Torrington, Conn., has introduced a new series of channel-shaped outer ring roller bearings featuring



a special cage design. The new cage design reportedly permits application of the bearings at higher than normal speeds. Designated as series HJ, the bearings are designed to be applied directly to hardened and ground shafts or used with inner rings which are also available. Sizes range from ⅜ to 4-in. bore. The new one-piece cage design separates roller guiding and roller retaining functions by employing a cage bar depressed within the roller pitch circle. Roller guidance takes place at the ends of the rollers and at the pitch line. Rollers are retained by the middle portion of the cage bar which is out of contact with the rollers during operation. Lubricant circulates freely through the bearing. More detailed information with a complete listing of sizes is now available in catalog 359, available on request from the company.

Ammonia Hose

Manhattan Rubber Division, Raybestos-Manhattan, Inc., Passaic, N. J., has introduced two constructions of agricultural am-



monia transport hose, designed to withstand working pressures to 300 psi and said to meet safety regulations for the use of anhydrous ammonia. The company also announced a new ammonia applicator hose.

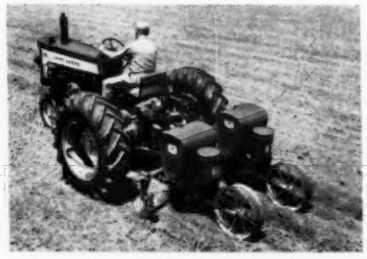
Paranite BW hose, constructed of corrosive resistant steel wire braid and strong cord braid with a pliant neoprene cover, is designed for loading storage tanks, trucks, and tractors. It is available in sizes ⅜ to 2 in. in 50-ft lengths.

Homoflex, constructed of cord braids applied at a precision balanced angle to achieve extreme flexibility with a special neoprene cover, is designed for filling tractors and for feed lines. It is available in sizes ¼ to 2 in. in 50-ft lengths.

Ammonia applicator hose is designed for soil applicators to carry the anhydrous ammonia to the tip of the tractor applicator in soil enrichment. It is available in $^3/_{16}$ to ½-in. sizes in long lengths. For more data write the company for Catalog M680.

Two New Unit Planters

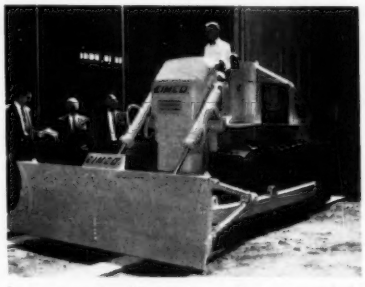
Deere & Company, Moline, Ill., announces two new members to its unit planter family. The 24-B uses natural-drop seed plates



and has a sloping hopper bottom for planting corn, soybeans, and similar smooth seed. The 25-B has combination-type seed hoppers that can be equipped to plant smooth seed or cotton seed. Extra equipment includes hill-drop, dry- and liquid-fertilizer, and herbicide and insecticide attachments. Planters are purchased in single units and attached to any 1¾ to 2¼-in. square tool bar.

New Crawler Tractor

The Eimco Corp., P.O. Box 300, Salt Lake City 4, Utah, has announced a new line of crawler tractors rated at 100-hp and



known as the Eimco 103. Features include up-front operator position for maximum visibility, and unitized construction, whereby massive steel castings are scientifically molded to the shapes and stress patterns. A heavy-duty torque converter and special transmission permits four gear selections in either forward or reverse, said to allow shifts from any speed (or from forward to reverse and back again) at any engine or tractor speed and load.

S-P Grain-Corn Combine

The Oliver Corp., 400 W. Madison St., Chicago 6, Ill., has announced its new Model 25, self-propelled combine, designed

to accommodate both small grain and corn headers. Design features include heavy-duty mountings and fittings, oversize threshing, separating and cleaning units, 108 sealed-for-life bearings, easy interchangeability of

(Continued on page 116)

king-size jobs call for king-size equipment

...and Ingersoll Discs

Note uniform soil-conditioning action of Ingersoll Discs on the 18½'-cut John Deere Rigid Disc Tiller

It takes big, husky, heavy-duty equipment to work king-size acreage in fast, easy-does-it style. Like this John Deere 15A Rigid Disc Tiller. Equipped with 27 sharp, tough Ingersoll discs, it takes 18½-foot bites in any kind of soil . . . gobbles up seedbed preparation and other jobs with time- and money-saving speed.

On *any* discing job, Ingersoll discs work better, easier, longer. Made of super-tough, *cross-rolled* TEM-CROSS® steel for maximum impact resistance, they slice through stubble, cover crops, trash, or hard-baked soil without cracking, tearing or curling.

That's the kind of dependability *your* customers want and expect. And that's why all implement manufacturers—yours included—furnish Ingersoll discs as original equipment on tillage tools.

INGERSOLL PRODUCTS DIVISION
Borg-Warner Corporation • Chicago 43, Ill.
WORLD'S LARGEST MANUFACTURER OF DISCS

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THE ONLY MANUFACTURER OF DURA-DISC—THE STEEL THAT IS THE ECONOMICAL REPLACEMENT FOR HIGH COST ALLOYS

. . . New Products

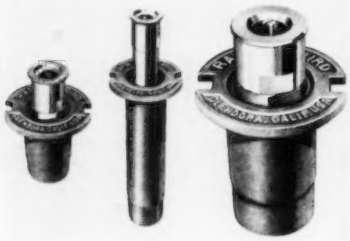
(Continued from page 114)

grain and corn headers, and a wide range of attachments and adjustments for special conditions.

The two-row picker type corn header has three high-speed, wide-lug gathering chains per row. The small grain header has a 10-ft gathering edge, and wobble-sickle drive. The unit is powered by a 6-cylinder engine and has a 4-forward-speed transmission, with hydraulic control of ground speed ranging from $^{8}/_{10}$ to about 15 mph.

Pop-Up Sprinklers

Rainy Sprinkler Sales, 609 W. Lake St., Peoria, Ill., and National Rain Bird and Engineering Corp., P.O. Box 547, Azusa,

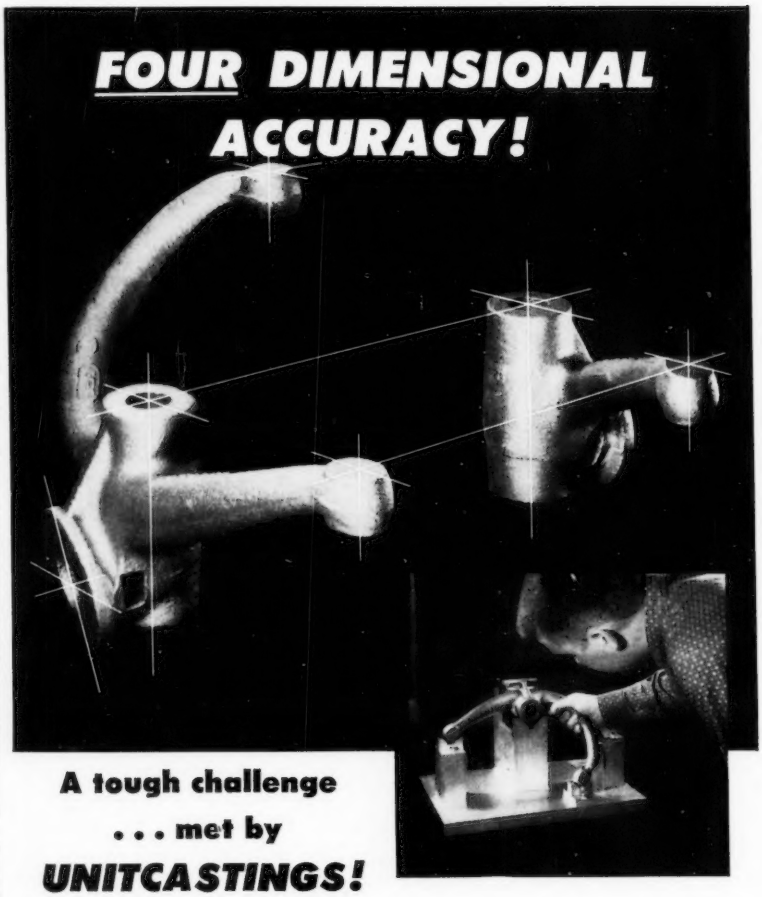


Calif., have announced production of two new series of "pop-up" sprinklers for lawn and turf areas. The 171 series is available in two styles, one with $1^{1}/_{16}$-in. travel and another with 2-in. travel. Full circle, quarter, third, half, and square patterns are available with ½-in. threaded connection. The large-size 181 series spray-type sprinkler has the normal $1^{1}/_{16}$-in. travel with ¼-in. threaded inlet for coupling directly to short nipples or risers in underground systems. This series is also available in full, quarter, half, and third circle models plus a square pattern.

Power Shift Transmission

Caterpillar Tractor Co., Peoria, Ill., has developed a new power shift transmission, featuring a new concept in the transmittal

of pipe-layer power. The new transmission is designed to provide instantaneous, one-level control of gear shifting without interruption of power and momentum. Heart of the new power-shifting arrangements is a planetary gear set, driven integrally by the engine flywheel, which transmits one-third of the engine torque directly to the transmission input shaft, and the remainder through the torque converter. The unit shown is being used to cradle the dope and wrap machine. In this operation, the shifting ease afforded by the power shift transmission allows the pipelayer to instantly match its speed to that of the wrapping unit. This benefit reportedly is not diminished by uncertain underfooting or grade changes, since shifting takes place without losing power and momentum.



A tough challenge . . . met by UNITCASTINGS!

Four-way specifications for this pair of steering arms combined tolerances difficult to hold in sand casting. Structural contour, surface limitations and internal consistency are accepted with regularity at Unitcast. However, a fourth requirement, *relationship of extremities* in such an unusual casting design is a tough problem to solve *economically!*

With a reasonable *finished* cost as an objective, Unitcast's quality control specialists recommended an unorthodox molding method. Special pattern equipment was built to control distortion in the spider-like arms . . . metal flow was redirected along with other unusual procedures. Finally, inspection jigs assured delivered accuracy.

Unitcastings *more* than meet customer's requirements and *cost remained competitive!* Unitcast can offer a similar service for your problems . . . call today for a Unitcast Sales Engineer.

UNITCAST CORPORATION, Toledo 9, Ohio
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Unitcast

SPECIFICATION STEEL CASTINGS

Baling and bale-handling by *one* man—made possible by a New Holland Super Hayliner 69, "50" Bale-Thrower and 750 Crop Drying Wagon.

A great new advance in mechanized haymaking:

"Hay-in-a-Day"... the ONE-Man Way!

Three major advances in mechanized hay handling will give farmers a faster, more reliable way of making excellent hay in the season just ahead:

Step 1: ONE-Man Baling and Loading!

Tests conducted at Penn State University reveal that, after mowing, conditioning and raking, a *bale-thrower* was used to automatically toss 16″ bales into wagons built for drying. No longer was there need for one, two or even three men in the wagon stacking longer, heavier bales. Final results proved that baler plus bale-thrower increased baling speed at least 50%!

Step 2: ONE-Man Crop Drying!

The second big break-through came when tests at Penn State proved that bales thrown into wagons would dry as efficiently as stacked bales. Penn State used a shed system with a portable crop dryer supplying the forced hot air. Results showed less overdrying of the top half of the wagon when compared with standard-packed. Bales were more uniformly dense because the bale-thrower removed each bale as soon as it was made, preventing jamming on the bale chute.

Step 3: ONE-Man Storing and Feeding!

The third big break-through came with one-man handling of both storing and feeding of smaller bales. Here, for the first time in this system, hay is moved by hand—and then only into a conveyor. A false end-gate pulls the load to the front automatically. Inside the mow, bales are discharged to right or left at any point by maneuvering ropes from the ground.

For a free showing of the new movie "Hay-in-a-Day . . . the ONE-Man Way," write New Holland Machine Co. Division of Sperry Rand Corporation, New Holland, Pennsylvania.

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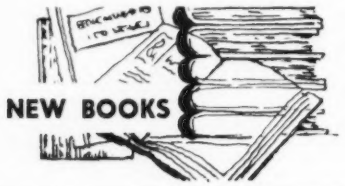

Phenolic Resins, by David F. Gould. Cloth. 5 x 7½ in. ix+213 pages. Illustrated and indexed. Published by Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y. $5.75.

This book presents the raw materials, production methods, and applications of the phenolic resins. It is the eleventh of a series, whose theme is guidance in application. It should give to the architect, the designer, the engineer, and the business man a better conception of the possibilities of phenolics; to the resin manufacturer and user information that may lead to better phenolics and even more effective use; to the laboratory man a refresher course on the practical aspects; and to the student a survey of an important industry.

Open-Channel Hydraulics, by Ven Te Chow. Cloth. 6¼ x 9¼ in. xviii + 680 pages. Illustrated and indexed. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y. $17.00.

Open-channel hydraulics deals with the design for flow in open channels and their related structures, and this book covers most of the advances that have occurred in the field during the past 10 years. It deals mainly with current American practice but also includes related information from many countries throughout the world. Material is divided into five main sections: Basic principles; uniform flow; varied flow; rapidly varied flow; and unsteady flow. There are 67 illustrative examples, 282 illustrations, 319 problems, and 810 references. It is a valuable text for students of engineering mechanics, hydraulics, civil, agricultural, sanitary, and mechanical engineering; and a helpful summary for practicing engineers.

Farm Engineering, by A. W. Riddolls. Cloth. 6¼ x 9¾ in. Illustrated and indexed. Published by the Government Printer, with copies and price available from the Government Printing Office, Lambton, Quay, Wellington, New Zealand.

Designed to give information on engineering principles and their application to farming for students in our schools and colleges, the book should also prove helpful to farmers who wish to employ modern, economical, and efficient methods on their farms. Engineering practices which are dealt with in the book include: Levelling, drainage, irrigation, and water supply. There is also given a full description of the construction of sheepyards, woolsheds, loading ramps, cowsheds, machinery sheds, hay barns, silos, fences, gates, and many other farm structures.

Filler Metal Comparison Charts, Second Series. 8½ x 11 in. 48 pages. Copies may be obtained from The American Welding Society, Dept. T, 38 W. 39th St., New York 18, N. Y. $2.50.

This booklet contains complete set of welding rod and electrode comparison charts, including the brand names of 78 companies. Fifteen AWS-ASTM specifications are involved and brands, as well as manufacturers names, are contained in two indexes. These charts should be helpful to all who specify welding materials or are concerned with the identification of brands and classifications of filler metals.

The Second Treasury of Contemporary Houses. Cloth. 8¾ x 11⅜ in. 232 pages. Published by F. W. Dodge Corp., 119 W. 40th St., New York 18, N. Y. $7.75.

In this book the editors of *Architectural Record* have assembled a new treasury of 44 of the most significant houses designed during the past few years. It is a book of ideas and its houses, ranging from the inexpensive to the luxurious and from a very few rooms to many, are described in the text and illustrated with over 400 photographs, drawings, and plans. Anyone interested in houses, whether he be architect, builder, or owner, will find this book of value.

1959 Engineering College Research Review. Paper. 6 x 9 in. xxiv + 445 pages. Copies may be obtained from the American Society for Engineering Education, University of Illinois, Urbana, Ill. $2.00.

According to this biennial review, 10,000 research projects are now under way in 118 leading engineering colleges across the nation, and expenditures on these research activities during the current year will total over $112,000,000. Complete titles for all projects under way in schools which hold ECRC membership are given in the 1959 survey of engineering college research. In addition, numbers of research personnel at each institution are listed, and research policies are summarized. There is also a complete index of research project subjects, to help locate activities in similar fields at different institutions.

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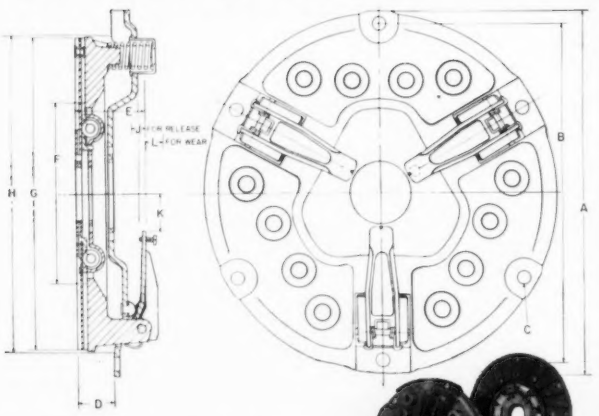

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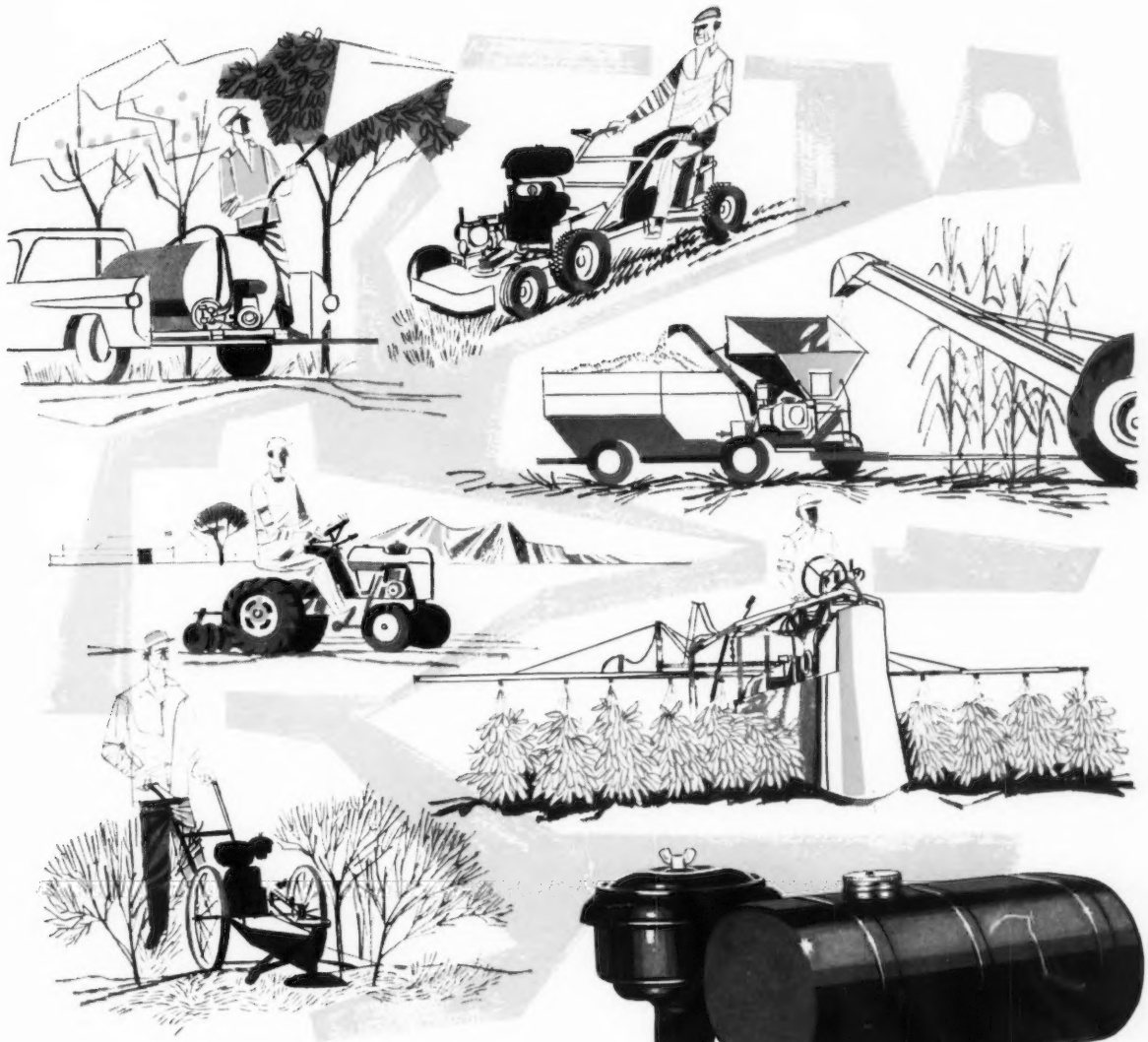

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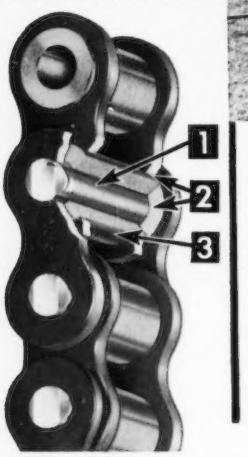

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MANUFACTURERS' LITERATURE

Literature listed below may be obtained by writing the manufacturer.

Electric Power Drives

Sterling Electric Motors, Inc., 5401 Telegraph Road, Los Angeles 22, Calif. — A simplified numbering system aids in quick and easy selection of electric power drives in revised Catalog No. 258, which contains 68 pages and includes over 8,000 ratings. Appearing for the first time are data and prices on the new "Sterlicone Multi-Shielded" line of drip-proof motors. Also included are prices, dimensions, and modifications for squirrel cage motors, gearmotors, speed reducers, right angle gearmotors, right angle variable speed drives, and variable speed drives, for ratings ranging from ¼ to 200 hp and for variable speed drives ranging from 4660 rpm down to 0.2 rpm in variations from 2:1 up to 10:1.

Tandem Drive Manual

Dayton Industrial Products Co., Tandem V-Drive Dept., 2001 Janice St., Melrose Park, Ill. — A 20-page illustrated industry service manual covers methods for the installation of V-belt drives on various types of truck tandem axles for both disc-type and spoke-type wheels. Also included are: Maintenance information; tire, wheel, rim, clamp, and spacer data; and tables on tractor-wheel spoke lengths, and tubeless and tube-type tires.

47-Ton Tree Crusher

R. G. LeTourneau Inc., Longview, Texas — Illustrated Bulletin 203 describes the new Series G-40 47-ton tree crusher, and also gives general data and operating features.

Moisture Loss Calculator

Radson Engineering Corp., Macon, Ill. — By using various scales printed on both sides of three-part calculator for obtaining fast answers to problems related to grain moisture content, the following information is quickly available: Profit or loss due to marketing grain at other than maximum moisture; net loss due to "tough grain" discount; shrinkage from drying grain; cost of drying due to moisture loss; most profitable harvest conditions; and when it is profitable to dry grain. The calculator may be obtained at a cost of 25 cents.

Sheathing and Subflooring Panels

Douglas Fir Plywood Association, 1119 "A" St., Tacoma 2, Wash. — Four-page folder, Form 59-600, describes and illustrates a new sheathing product called Ply-Scord. Included are tables of recommendation showing where and how the sheathing panels should be used, as well as nailing data, and applications.

The new product conforms with the revised Commercial Standard CS122-56. Copies of the amended Western Softwood Plywood Commercial Standard CS122-56 may be obtained from Douglas Fir Plywood Assn. Quantity prices — $4.00 per 100.

Polyethylene Pond and Ditch Liners

Gering Plastics Div. of Studebaker-Packard Corp., N. Seventh St. and Monroe Ave., Kenilworth, N. J. — Ger-Pak Agri-News Bulletin No. 9 contains the latest authoritative information on the use of black polyethylene sheeting as liners for ponds and ditches, based on actual installations and reflecting several years field experience. It also provides explicit details for a better understanding of the requirements for controlling seepage losses through use of polyethylene plastics.

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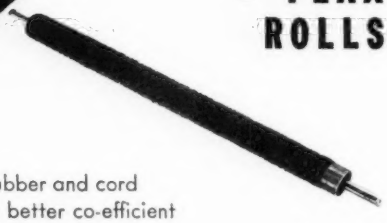

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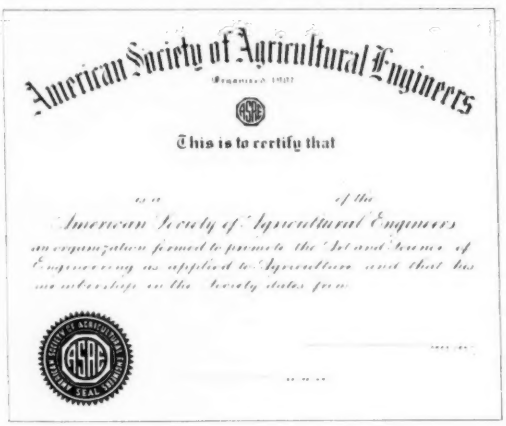
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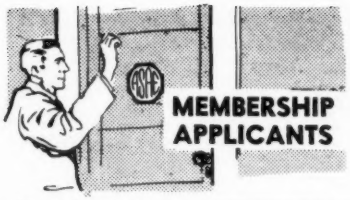

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Ackerman, Thomas M. — Agr. engr., electric operations and loans div., Rural Elecn. Administration, USDA, Washington 25, D.C.

Bagnall, Larry O. — Engr. scientist, Allis-Chalmers Mfg. Co. (Mail) 1415 S. 166th St., Waukesha, Wis.

Batel, Wilhelm — Prof., dir. of the dept. of basic research in agr. eng., chief of the Institut fur Landtechn. Grundlagenforschung. (Mail) Forschungsanstalt fur Landwirtschaft, Bundesallee 50, Braunschweig-Volkenrode, Germany

Birkholz, Raymond I. — Asst. div. chief engr., Farm Equip. and Eng. Center, International Harvester Co., 7 So. 600 County Line Rd., Hinsdale, Ill.

Clardy, Elmer L. — Serv. supervisor, International Harvester Co., 3601 W. 65th St., Little Rock, Ark.

Clayton, Ralph E. — Spec. and instructor, extension branch, Ontario Dept. of Agr., W.O.A.S., Ridgetown, Ont., Canada.

Ferguson, Frank H. — Vice-pres., Cornhusker Tractor and Equipment Co. (Mail) 1717 Alpha, North Platte, Nebr.

Frazier, E. Henry, Jr. — Sales eng., Aeroglide Corp., Box 1839, Raleigh, N. C.

Freeland, John, Jr. — Mgr., cord belt dept., Manhattan Rubber Div., Raybestos-Manhattan, Inc. (Mail) 141 Whitney Ave., Pompton Lakes, N. J.

Fyrciak, George, Jr. — Salesman, Farm and Industrial Center. (Mail) 6945 Owosso Road, Fowlerville, Mich.

Gerber, Don B. — Sales rep., Granite City Steel Co., Granite City, Ill.

Jenkinson, Rodney A. C.—Sales rep., Messrs. Gailey and Roberts, Ltd., P.O. Box 40, Nakuru, Kenya, East Africa

Kerber, Dathan R. — (With the U.S. Air Force). (Mail) 609 Highway Blvd., Fort Walton Beach, Fla.

King, Robert W. — Chief engr., Massey-Ferguson, Inc. (Mail) 1283 Buckingham, Birmingham, Mich.

Kittle, Carl E. — Jr. engr., John Deere Research and Eng. Center. (Mail) 1708 Schreiber, Cedar Falls, Iowa

Knox, A. O. — Sales prom. supervisor, International Harvester Co., 1986 W. Beaver St., Jacksonville, Fla.

Kozlowski, Henry T. — Sales engr., Chain Belt Co. (Mail) 228 Newton Ave., Glen Ellyn, Ill.

Lasswell, Fred, Jr.—Owner, Lasswell Studios, 329 Bayshore Dr., Tampa, Fla.

Long, John R. — Civil engr., (SCS) USDA. (Mail) 1813 Kearney St., Casper, Wyo.

McLeland, Harold H. — Chief engr. and head of quality control, Waterloo Div., L. H. Schultz Mfg. Co., Parker and Broadway, Waterloo, Iowa

Mack, Charles B. — Agr. engr., Collier Carbon and Chemical Corp. (Mail) P.O. Box 128, Brea, Calif.

Merker, John F. — Sales engr., Chain Belt Co., 3033 Excelsior Blvd., Minneapolis 16, Minn. *(Continued on page 124)*

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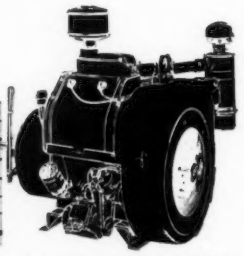

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. . . Membership Applicants

(Continued from page 123)

Petty, Clyde — Civil engr. and asst. proj. engr., (SCS) USDA. (Mail) 136 Cherrydale Dr., Greeneville, Tenn.

Qazi, Abdul R. — Graduate student, Eng. College, Colorado State Univ. (Mail) 627½ S. Mason, Fort Collins, Colo.

Sammarco, P. — Product engr., Farm Equip. and Eng. Center, International Harvester Co., 7 So. 600 County Line Rd., Hinsdale, Ill.

Sharpe, Alex B. — Sales rep., The S. K. Wellman Co., 1500 S. Western Ave., Chicago, Ill.

Sharratt, William J. — (With the U.S. Air Force). (Mail) Meadows Trailer Court, Mt. Home, Idaho

Sturges, Paul M. — Owner, Sturges Heat Recovery, Inc., Stone Ridge, N. Y.

Thayer, Ralph S. — Pres., Baldwinsville Farm Supply Inc., R.R. 1, Downer Street Road, Baldwinsville, N. Y.

Wall, Henry L.—Civil engr. (design), (SCS) USDA, 7600 W. Chester Pike, Upper Darby, Pa.

TRANSFER OF MEMBERSHIP

Baxter, Denver O. — Asst. proj. and asst. agr. engr., agr. eng. dept., The Univ. of Tennessee, Knoxville 16, Tenn. (Associate Member to Member)

Coates, Edwin S. — Eng. spec., Agr. Ext. Service, North Carolina State College, 314 Ricks Hall, Raleigh, N. C. (Associate Member to Member)

Koepele, John C. — Product des. II, Massey-Ferguson, Inc. (Mail) R.R. 1, Grand Ledge, Mich. (Associate Member to Member)

Mahidas, Patel M. — Mech. engr., Messrs. Patel Eng. Co., Ltd. (Mail) 3, Chandra Niwas, Sahar Road, Andheri, Bombay 59, India (Associate Member to Member)

Ritchie, Ray M., Jr. — Ext. spec., Agr. Eng. Ext., North Carolina State College, Raleigh, N. C. (Associate Member to Member)

Rodda, Errol D. — Instructor, agr. eng. dept., Univ. of Illinois, Urbana, Ill. (Associate Member to Member)

Sewell, John I. — Instructor, agr. eng. dept., North Carolina State College. (Mail) Box 5906, State College Station, Raleigh, N. C. (Associate Member to (Member)

Trepanier, Peter J. — Product engr., Armco Drainage and Metal Products, Inc. (Mail) 205 Fulton Lane, Middletown, Ohio (Associate Member to Member)

Walpole, Ernest W. — Mgr., agr. dept., Masonite Corp., 111 W. Washington St., Chicago 2, Ill. (Associate Member to Member)

Warrick, Woodley C. — Ext. spec., Agr. Eng. Ext. Service, North Carolina State College, Raleigh, N. C. (Associate Member to Member)

Wickert, Charles J. — Des. engr., S. L. Allen and Co., Inc. (Mail) 1836 N. Hills Ave., Willow Grove, Pa. (Associate Member to Member)

Wiser, Edward H. — Instructor, agr. eng. dept., North Carolina State College. (Mail) 1617 Sunrise Ave., Raleigh, N.C. (Associate Member to Member)

STUDENT MEMBER TRANSFERS

Baker, Franklin — (Auburn University). (Mail) 220 Auburn Hall, Auburn, Ala.

Bickert, William G. — Agr. eng. dept., North Dakota Agricultural College, Fargo, N.D.

Buckingham, Frank E. — (Iowa State University). (Mail) 7731 Birch, Prairie Village, Kans.

(Continued on page 126)

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Willard Cyrus, farmer of Sisters, Oregon, needed a land leveller for terracing. In constructing it, he utilized angle iron, old truck wheels and a hydraulic cylinder from a discarded airplane wing.

It operates on Texaco Regal Oil R&O. Mr. Cyrus (right) gets all his Texaco products from Don Wells, driver for Texaco Consignee B. A. Litehiser. This progressive farmer, like farmers everywhere, has found that it pays to power and lubricate his farm machinery with Texaco products.

Mr. Cyrus is mighty resourceful when it comes to solving problems. He also welded a handy winch on his tractor, and used the differential of an old car. It operates off the power take-off.

Bearings bear up better with Marfak

H. Lee Cherry farms 450 acres near Washington, North Carolina. He raises tobacco, soy beans, grain, cattle and pigs. Here (on tractor) he stops for a neighborly talk with Texaco Distributor H. G. Winfield, who supplies Lee with Texaco products for his farm equipment. This time he has made a delivery of Texaco Marfak. Lee prefers Marfak lubricant, because experience proved that it best cushions bearings against the brutal beating they take in field work. Marfak forms a tough collar around open bearings, sealing out dirt and moisture. Marfak won't drip out, wash out, dry out or cake up. Mr. Cherry is another of the countless farmers all over the country who have found that *it pays to farm with Texaco products.*

BUY THE BEST...BUY TEXACO

TUNE IN: METROPOLITAN OPERA, SAT. AFTERNOONS, CBS-RADIO; TEXACO HUNTLEY-BRINKLEY REPORT, MON. THROUGH FRI., NBC-TV

PERSONNEL SERVICE BULLETIN

Note: In this bulletin the following listings current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated. "Agricultural Engineer" as used in these listings is not intended to imply any specific level of proficiency or registration as a professional engineer. Items published herein are summaries of mimeographed listings carried in the Personnel Service, copies of which will be furnished on request. To be listed in this bulletin, request form for Personnel Service listing.

Positions Open – August – O-259-950, 259-951. **September**–O-219-954, 264-955, 275-956, 285-957, 277-958. **October** – O-315-960, 323-961, 323-962, 324-963. **November**–O-327-964, 328-965, 341-966, 320-967, 345-968, 353-969, 360-970, 352-971, 358-972, 361-973. **December** – O-378-974, 384-975, 386-976, 387-977, 370-980, 394-981, 404-982. **January** – O-395-983, 395-984, 441-985, 452-986.

Positions Wanted – August – W-210-36, 224-37. **September** – W-249-40, 258-41, 245-43, 267-44, 269-45. **October** – W-307-47, 321-49. **November** – W-330-50, 278-51, 284-52, 335-53, 336-54, 343-55, 329-56, 363-57. **December**–W-390-59, 388-60. **January** – W-411-61, 426-62, 427-63, 433-64, 437-65.

NEW POSITIONS OPEN

Assistant Manager for rural electric cooperative, to initiate, plan and execute, under general supervision, work programs to increase efficiency and production. Midwest location. Age 40 or under. Formal education in management, budget planning, personnel work, public speaking, cost controls, and (optional) electrical engineering. Experience desirable in supervisory or production control and personnel work, preferably in field of electric power distribution. Good health, neat appearance, church activity, able to mix well with people. Good opportunity with organization serving over 13,000 members on 3,500 miles of lines. Salary $7,500 maximum. O-4-601

Engineers for research, design and test of power lawn tools and small engines, with an established multi-plant manufacturer. Midwest location. BSAE, BSME or equivalent. Some experience desirable in mechanical equipment design and development. Usual personal qualifications for commercial engineering. Excellent opportunity for creative work and advancement. Salary open. O-11-602

Agricultural Engineers (graduate fellowships) to work for MSAE with concentration on cotton ginning engineering in a southeastern state college. Age under 35. BSAE or BSME. Acceptable for admission to graduate school. Interest in cotton ginning research or education. Application deadline for 1960-61 school year is April 1. Salary $2,500 for 12 months. O-22-603

Design Engineer for research, test, and development of new machines for expanding the line of an established manufacturer of specialized farm equipment. Midwest location. Graduate mechanical engineer. Some design experience in the farm equipment field. Excellent opportunity for advancement. Salary open. O-23-604

Agricultural Engineer (Associate) for research and supervision of graduate program in soil and water field, with land grant university in the Southeast. PhD preferred. MSAE or equivalent required. Excellent opportunity for develop ng research program. Salary open. O-35-605

NEW POSITIONS WANTED

Agricultural Engineer for development, research, extension or teaching in power and machinery, with public service or industry. Western or foreign location. Married. Age 31. No disability. BSAE, Washington State University, 1957. MSAE, Purdue University, expected June 1960. Farm background. Summer work with various engineering firms. Product engineer one year. Available July 1960. Salary open. W-3-1

Agricultural Engineer for teaching or research in power and machinery with a college. Any location. Married. Age 26. No disability. BSME and MSAE. Experience as graduate assistant. Commissioned service in Navy 3 years. Available June 1960. Salary $7,500. W-10-2

Agricultural Engineer for design, development, or management in power and machinery with manufacturer in Midwest. Married. Age 36. No disability. BSAE, 1951, North Carolina State College. Registered professional engineer. Varied design, development and management experience in metal working industry 9 years. U.S. Navy 4 years with promotions to aviation machinists mate. Available on reasonable notice. Salary $10,000. W-15-3

Agricultural Engineer for design or sales in power and machinery or rural electric field with federal agency, manufacturer, or distributor. Any location. Single. Age 24. Vision corrected. BSAE, 1960, Louisiana Polytechnic Institute. Farm background. Available February 1. Salary open. W-16-4

Agricultural Engineer for teaching or research in electric power and processing or farm structures field, in public service. Any location. Will consider some travel. Married. Age 26. Vision corrected with glasses. BSAE, 1959; MSAE expected June 1960, Kansas State University. Farm background. Student trainee with SCS two summers. U.S. Army 2 years. Available June 15, 1960. Salary open. W-17-5

Agricultural Engineer for design and development in power and machinery or rural electric field with manufacturer, processor, or distributor in Southeast. Married. Age 24. No disability. BSAE, 1957, Alabama Polytechnic University. Farm background. Design experience 3 months prior to call to military service. Commissioned service in armored division, 2 years. Available May 1960. Salary open. W-5-6

Agricultural Engineer for design, development, or research in power and machinery with manufacturer. Location, East, Midwest or Florida. Willing to travel. Single. Age 26. Vision corrected. BSAE, 1955, Pennsylvania State University. Design engineers training program 14 months. Design engineer in U.S. Army biological warfare laboratory 21 months. Project engineer with farm equipment manufacturer, 14 months. Available on 2 weeks notice. Salary open. W-31-7

Agricultural Engineer for writing, product training, advertising or engineering field test work in power and machinery with manufacturer. Any location. Married. Age 38. No disability. BSAE, 1951, Michigan State University. Experience in service department of major manufacturer since graduation, with promotions to assistant service manager. Naval Reserve service 21 months. Available on reasonable notice. Salary open. W-33-8

Agricultural Engineer for design, development, or research with manufacturer or consultant. Any location. Willing to travel. Single. Age 28. No disability. BSAE, 1957, Kansas State University. Farm background. Summer work in tractor testing. One year as research engineer with tractor manufacturer. Agricultural engineer 18 months with International Voluntary Services in Viet Nam under ICA contract, in power and machinery and irrigation work. Available January 1, 1961. Salary open. W-37-9

Agricultural Operations man for service, management, company representative, or marketing work in equipment field with manufacturer, distributor, or farming operation, in East or Midwest. Willing to travel. Married. Age 29. No disability. BS in agricultural economics. Dairy farm background. Military service completed. Experience in supervising irrigation service on part of a large truck crop farm 3 years. Available on reasonable notice. Salary $5,600-6,000. W-30-10

RESEARCH NOTES

Brief news notes and reports on research activities of special agricultural-engineering interest are invited for publication under this heading. These may include announcements of new projects, concise progress reports giving new and timely data, etc. Address: Editor, AGRICULTURAL ENGINEERING, St. Joseph, Michigan.

Report Discusses Cracking of Sweet Cherries

Ways of reducing or preventing cracking of sweet cherries are discussed in a research report by USDA-Michigan agricultural engineers. Authors are J. H. Levin of the Harvesting and Farm Processing Research Branch, AERD, ARS; C. W. Hall of the Michigan Agricultural Experiment Station, and A. P. Deshmukh, former Michigan State University graduate student.

Results of their experiments show that cracking can be reduced or prevented by: (a) reducing water absorption, (b) increasing transpiration rate and decreasing expansion of cells, and (c) increasing the modulus of elasticity of the skin to prevent splitting.

Reprints of the report are available from the Michigan Agricultural Experiment Station, East Lansing. The report appeared in the Station's Quarterly Bulletin, Vol. 42, No. 1, pages 133 to 141, August 1959.

Awards to Adrian, Franks

Agricultural engineers Paul A. Adrian and Gerald N. Franks have received $300 USDA awards for overall excellence in conducting research.

Mr. Adrian, of AERD in USDA's Agricultural Research Service, was cited for developing small fruit harvesting and handling equipment. He worked in cooperation with R. B. Fridley, agricultural engineer of the California Agricultural Experiment Station, Davis.

Mr. Franks was cited for developing and adapting cottonseed conveying, drying, and cleaning equipment and methods. Also of AERD, he is a member of the cotton ginning research staff at the U.S. Cotton Ginning Laboratory, Stoneville, Miss.

Report on Potato Studies

A new research report of USDA's Agricultural Research Service points out why pallet boxes should not be filled with Irish potatoes in the field.

Author of the report, George W. French of AERD concludes: (a) There is no prospect of reducing personnel requirements or increasing labor efficiency by substituting field filling of pallet boxes for yard filling operation. (b) Considerations of equipment costs, injury to the potatoes, and harvesting efficiency indicate that pallet boxes can be filled more economically at the storage than in the field. Commercial equipment is available for yard filling of pallet boxes.

Mr. French is stationed at the Red River Valley Potato Research Center, East Grand Forks, Minn.

Copies of his report are available from the Information Division, Agricultural Research Service, U.S. Department of Agriculture, Washington 25, D.C. Request ARS 42-36, October 1959, "Field Filling of Pallet Boxes Not Recommended for Irish Potatoes."

. . . Membership Applicants

(Continued from page 124)

Carroll, Bruce E. — (Iowa State University). (Mail) Schleswig, Iowa

Collins, William H. — (Virginia Polytechnic Institute) Instructor, agr. eng. dept., Univ. of Massachusetts. (Mail) 525 Lincoln Apts., Amherst, Mass.

Downs, C. William—(Iowa State University). (Mail) Polk City, Iowa

Fowler, John E., Jr. — (University of Tennessee). (Mail) R.R. 3, Kenton, Tenn.

Kemper, Mark J. — (Iowa State University). (Mail) 201 N. Garnavillo, Anamosa, Iowa

Koon, Joe L. — c/o Agr. eng. dept., Auburn University, Auburn, Ala.

Mensch, Robert L. — (Iowa State University). (Mail) R.R. 1, Truman, Minn.

Nunn, Ernest W. — (Auburn University). (Mail) Athens Plow Co., Athens, Tenn.

Patterson, Neafie D. — (Virginia Polytechnic Institute). (Mail) International Harvester Co., Hinsdale, Ill.

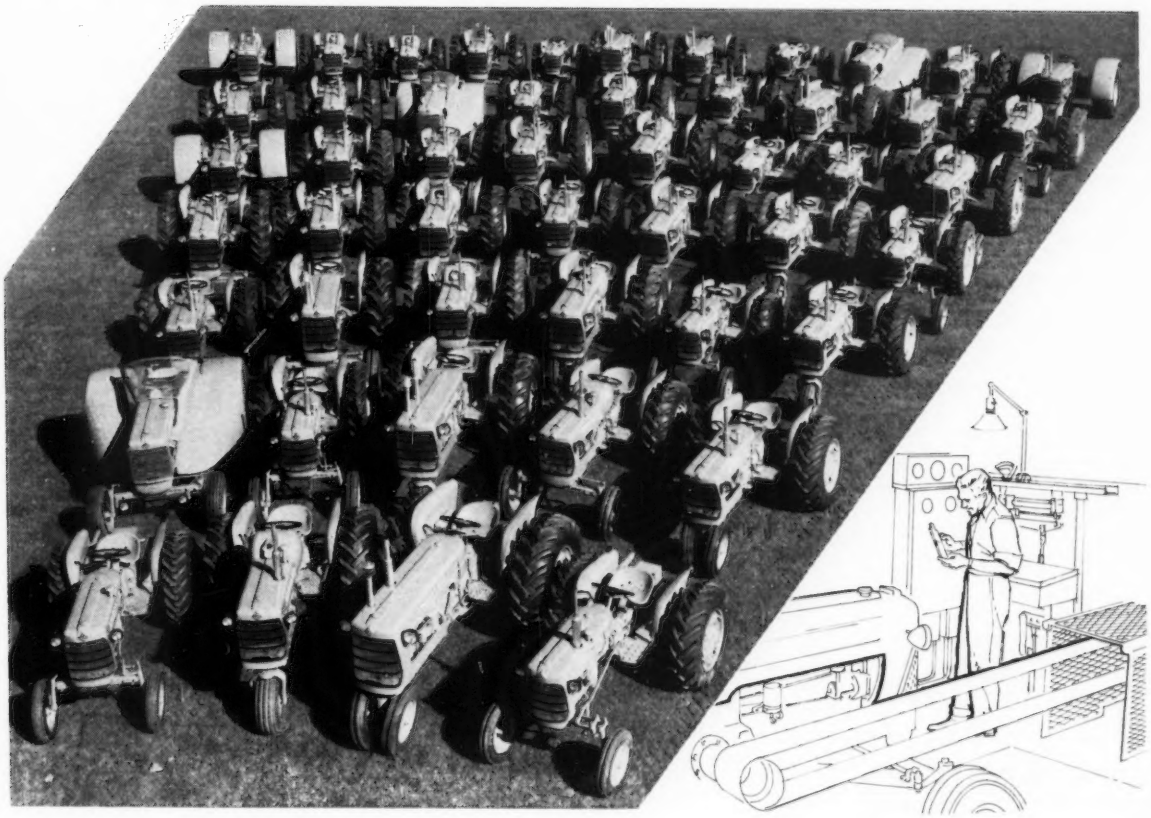
Pruitt, Daniel W. — Agr. eng. dept., Virginia Polytechnic Institute, Blacksburg, Va.

Reinhart, Robert D. — (Iowa State University). (Mail) R.R. 2, Ridgeway, Iowa

Rose, John B. — (Virginia Polytechnic Institute) Carrsville, Va.

Sestak, Robert R. — (South Dakota State College). (Mail) Tabor, S. D.

Ready Now for a New Decade...



50 Great D-Series Tractors from Allis-Chalmers Research

Research and engineering at Allis-Chalmers have greatly widened the application of new power principles for tractor users everywhere.

Tractor work becomes easier, faster, more productive whether it's used in 6-row corn farming or tobacco a row at a time . . . by grain growers, fruit and vegetable growers, or cotton and rice producers.

Pictured here is the Allis-Chalmers tractor line for the sixties — from the 1-row D-10 to the big D-17 models.

In utility tractors, Allis-Chalmers has brought major new performance advancements. Shuttle-Clutch operation with the D-14 Utility Tractor is a good example.

More effective power to serve more people in all areas, whatever they grow, is the Allis-Chalmers story for 1960 and beyond.

ALLIS-CHALMERS, FARM EQUIPMENT DIVISION, MILWAUKEE 1, WISCONSIN

ALLIS-CHALMERS

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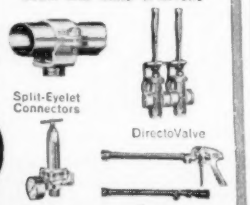

the BADGE of him who BELONGS

DESPITE the *presumption* it sets up, mere membership in the American Society of Agricultural Engineers is no *proof* of a man's high rank in technical talent. It does prove that he has met certain minimum requirements and has earned the esteem of colleagues who sponsored his application for membership.

But the Society emblem is *evidence* that native talent, be it great or small, is enriched by fraternity with the personalities whose minds fuse to form the pattern of progress in the methods and mechanics of agriculture. The wearer of the emblem waits not for the debut of an idea, but is present at its birth and helps to guide its growth.

Be you novice or veteran, your membership in the organized profession adds something to your efficiency, your vision, your influence as an individual engineer. The Society symbol on your lapel is token that you "belong." Wear it.

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With blue ground for Fellows, Members, and Associate Members — furnished either in pin with safety clasp or lapel button — $3.50 each.

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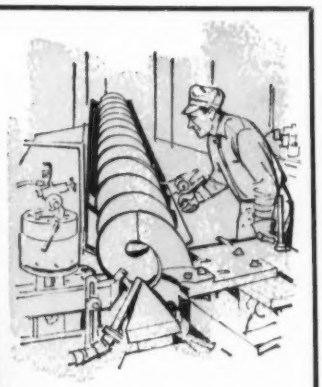
GLEANER-BALDWIN COMBINE, product of Allis Chalmers Mfg. Co., uses Link-Belt auger with opposing flights for smooth, efficient grain harvesting. Other Link-Belt screw conveyors within combine elevate, convey and unload harvest.



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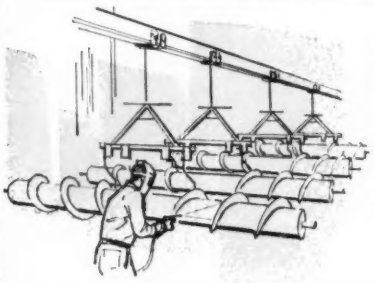

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make sure all Link-Belt augers are delivered in perfect operating condition. Straightness is carefully checked before shipping . . . painting prevents rusting . . . extra care is taken in handling, loading.

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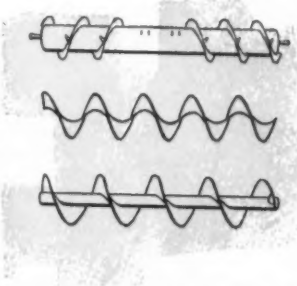

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Simplicity, strength, exactness of construction—all are combined in Link-Belt augers to assure long-lived, dependable performance on your machine.

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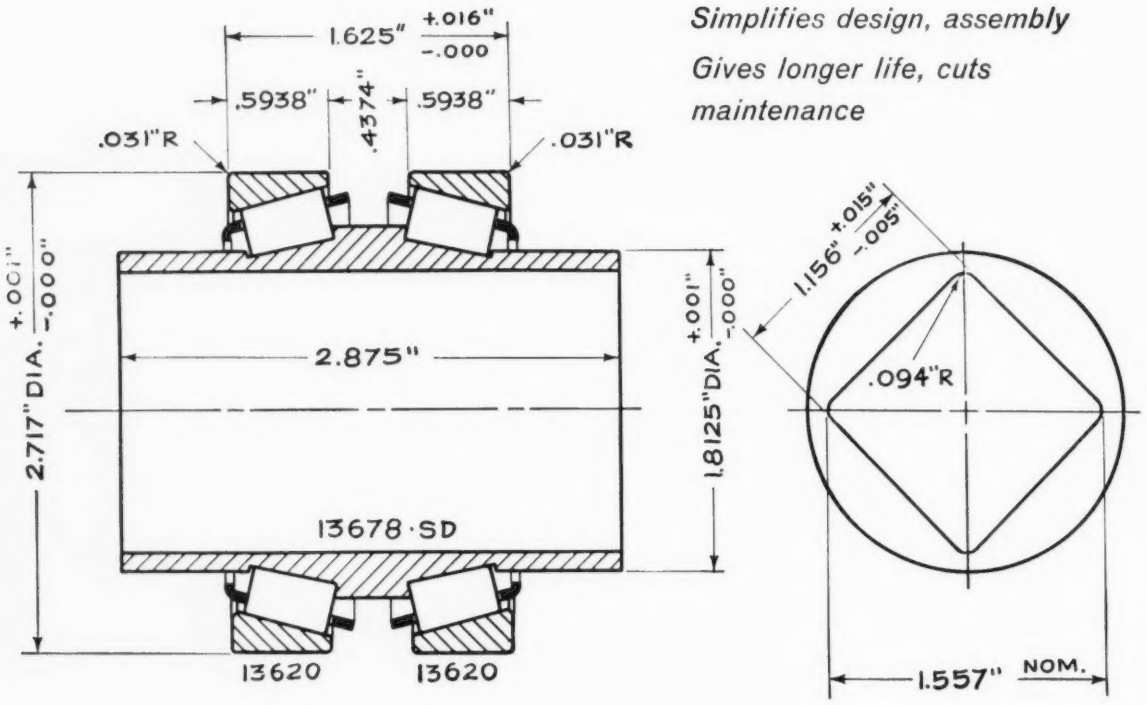
New Timken® square bore bearing for disc hanger



Simplifies design, assembly

Gives longer life, cuts maintenance

THE new Timken® square bore bearing (above) for disc hangers opens new savings and improvement opportunities for agricultural engineers and farm equipment manufacturers.

The square bore simplifies mounting or assembly and disassembly. The bearing can be mounted directly with square gang bolts. This eliminates any possibility of turning on the gang bolt.

Another important feature is the extended cone with a hardened, smooth ground surface. It enables seals to operate at maximum efficiency in keeping dirt and dust out, lubricant in, maintenance down.

This new Timken square bore bearing is another example of Timken Company pioneering. It has all the usual advantages of Timken tapered roller bearings that help agricultural engineers answer three big problems: 1) combination loads; 2) dirt; 3) ease of operation. And this new bearing has been tested and proved in two years' field service under all operating conditions.

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